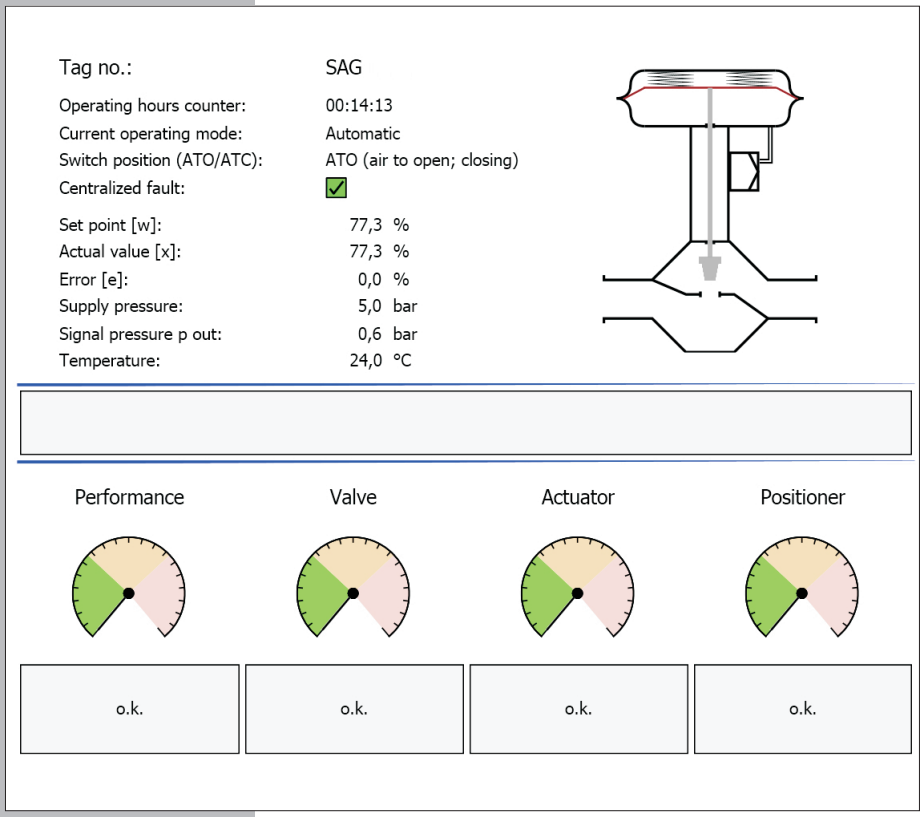
Series 3730
Electropneumatic Positioner
Type 3730-6

Valve Diagnostics EXPERTplus



Operating Instructions

EB 8389-1 EN

Firmware version 1.0x

Edition June 2011

Definitions of the signal words used in these instructions

NOTICE
indicates a property damage message.

Note: *Supplementary explanations, information and tips*

Contents

1 Description

1.1 General

These instructions EB 8389-1 EN supplement the standard Mounting and Operating Instructions for Type 3730-6 (EB 8384-6 EN).

EXPERTplus is a diagnostic firmware integrated in the positioner which allows the predictive, status-oriented maintenance of pneumatic control valves.

EXPERTplus records the condition of the valve while the process is running (automatic mode) and generates messages on the required maintenance work. In addition, numerous tests can be performed in manual mode to pinpoint emerging faults.

The diagnostic functions of EXPERTplus are completely integrated in the positioner. Diagnostic data are compiled, saved and analyzed in the positioner itself. Classified status messages on the state of the valve are generated from the analysis.

Operation using TROVIS-VIEW 4/DD/DTM/EDD

Using the TROVIS-VIEW 4 software or DD/DTM/EDD, EXPERTplus allows the parameters to be viewed and set conveniently.

- **TROVIS-VIEW 4** · SAMSON interface for configuration and setting parameters of various SAMSON devices
- **DTM** · Device Type Manager (determines the device and communication properties)
- **DD/EDD** · Device Description/enhanced Device Description

The data must be downloaded onto the positioner to allow parameter settings to become effective.

Local operation

Some parameter settings can be made at the positioner as well as using the TROVIS-VIEW software. Each of these parameters is assigned a code written in parentheses in these instructions. A detailed list of all parameters that can be changed at the positioner is included in the standard Mounting and Operating Instructions of the Type 3730-6 Positioner (EB 8384-6 EN).

The operation described in the following sections applies to TROVIS-VIEW 4. The default settings of the positioner and TROVIS-VIEW 4 are written in square brackets [ ].
Settings in the gray tables apply to operation with TROVIS-VIEW 4.

1.2 Start-up

1.2.1 Start-up parameters

To able to fully use the valve diagnostics, the positioner must be initialized. During initialization, the positioner adapts itself to the friction conditions and signal pressure requirements of the valve.
Various modes of initialization are available for selection: maximum range (MAX), nominal range (NOM), manual setting 1 (MAN) and manual setting 2 (MAN2).

- **Maximum range (MAX)**
  Initialization mode for simple set-up of valves with two clearly defined end positions, e.g. three-way valves
- **Nominal range (NOM)**
  Initialization mode for all globe valves
- **Manual setting 1 (MAN)**
  Initialization mode for all globe valves with manually entered OPEN position
- **Manual setting 2 (MAN2)**
  Initialization mode for all globe valves with manually entered end positions (OPEN and CLOSED positions)

To initialize the positioner, the type of application, pressure limit and start-up parameters required for the selected initialization mode need to be entered.

Note: *Positioner start-up is described in detail in the Mounting and Operating Instructions EB 8384-6 EN.*

An additional reference measurement to plot the valve signature is required for the functions to monitor friction, supply pressure, seat leakage, actuator springs, course of the end positions and zero point (refer to section 4). If the positioner has been initialized with the SUB mode (substitute calibration), the reference curves required for the diagnostics cannot be recorded. This reference measurement is performed automatically after initialization when *Initialization including valve signature* is set to Yes.

Start-up

- Type of application (Code 49 - h0): [Control valve], On/off valve
- Initialization mode (Code 6): [Maximum range (MAX)], Nominal range (NOM), Manual setting 1 (MAN), Manual setting 2 (MAN2)
- Initialization including valve signature (Code 48 - h0): **[Yes]**
- Pin position (Code 4): [Off], 17, 25, 35, 50, 70, 100, 200 mm, 90°
- Pressure limit (Code 16): 1.4 to [7.0] bar

During the positioner initialization, the Kp and Tv levels are optimally set. If the positioner tends to overshoot impermissibly due to other disturbances, the proportional-action coefficient Kp level and the derivative-action time Tv level can be adapted accordingly after initialization. The Tv level can be incremented until the required control behavior is achieved. The Kp level can be reduced gradually when the maximum Tv level of 4 is reached.

NOTICE
Changes in the Kp level affect the set point deviation!

After changing the Kp level, we recommend recalibrating the input filter in the positioner. To do this, select and execute *Fine-tuning after Kp change*.

Start-up > Control parameters

- Proportional-action coefficient Kp level (Code 17): 0 to 17, [7]
- Derivative-action time Tv level (Code 18): Off, 1 to 4, [2]
- Fine-tuning after Kp change

1.3 Diagnostic functions

There are two main groups of diagnostic functions available

1. **Monitoring** (in-service)

   Data are saved and analyzed by the positioner while the process is running (closed-loop operation is not disrupted). The positioner can follow the reference variable during this time. A classified status or error message is generated when the positioner detects an event.

2. **Dynamic tests** (out-of-service)

   Similar to in-service monitoring, data are saved and analyzed by the positioner. However, in this case, the valve position is not determined by the reference variable. Instead, the valve moves to a certain position defined by the test settings. Dynamic tests can only be started when the conditions in the plant allow it (e.g. plant shutdown or service work in the workshop). For reasons of safety, these dynamic tests, except for partial stroke testing, can only be performed in the MAN operating mode.

   An insufficient electric power supply or when the solenoid valve is energized/ the forced venting is activated causes the dynamic test to be canceled and the positioner to move to the fail-safe position.

1.3.1 Type of application

Depending on the type of application that has been selected, various diagnostic functions are available in EXPERTplus. There are two different types of application: **Control valve** and **On/off valve**. Depending on the type of application selected, the positioner behaves differently in the automatic mode (AUTO):

- **Control valve**
  The positioner follows continuously the reference variable. The valve position appears in % on the display.
- **On/off valve**
  Discrete analysis of the reference variable.
  The valve position in % and **O/C** (Open/Close) appear in alternating sequence on the display. Refer to section 5.

1.3.2 Analysis

Table 1 lists the diagnostic functions and statements on the valve condition (depending on the type of application).

Table 1 · Diagnostic functions and test analyses

Diagnostic function	Control valve	On/off valve	Diagnosis	Refer to
Monitoring				
Data logger	•	•	Depending on trigger condition selected	Sec. 3, p. 19
Valve signature	•	⊗	– Friction – Supply pressure – Actuator springs – Pneumatic leakage	Section 4, page 25
On/off valve	–	•	– Breakaway time – Transit time – Final travel/angle value	Section 5, page 33
Valve position histogram	•	⊗	– Course of the manipulated variable range – Manipulated variable range	Section 6, page 37
Set point deviation histogram	•	•	– Manipulated variable range limitation – Seat leakage – Positioner-valve linkage – Mean set point deviation	Section 7, page 40
Cycle counter histogram	•	•	– Packing leakage – Dynamic load factor	Section 8, page 45
Leakage sensor	•	•	– Seat leakage	Sec. 9, p. 49
Course of end position	•	•	– Course of end position – Zero point shift	Section 10, page 63
Dynamic tests				
Valve dead band	•	•	– Dead band	Sec. 11, p. 65
Partial stroke test (PST)	•	•	– Overshooting – Dead time – T86 – Settling time	Section 12, page 69
Full stroke test (FST)	•	•	– Overshooting – Dead time – T86 – Settling time	Section 13, page 77

• Full scope of functions
⊗ Function is performed, but not analyzed
– Function is not performed

2 Monitoring

2.1 Status messages

The valve diagnostics integrated in the positioner generates classified status messages.

Messages, which have been generated based on the analysis of the diagnostics, can be classified separately according to the possible cause. Refer to sections 4 to 13.

The following classifications are possible:

- **No message**
  If an event is classified as 'No message', this event does not have any affect on the condensed state of the positioner.
- **Function check**
  Test or calibration procedures are performed in the positioner. The positioner is temporarily unable to follow its control task as long as the procedure is taking place.
- **Maintenance required/Maintenance demanded**
  The positioner still performs its control task (with restrictions). A maintenance demand or above average wear has been determined. The wear tolerance will soon be exhausted or is reducing at a faster rate than expected. Maintenance is necessary in the medium term.
- **Out of specification**
  The positioner is operated outside specified operating conditions.
- **Failure**
  The positioner cannot perform its control task due to a functional fault in the positioner itself or in one of its peripherals or an initialization has not yet been successfully completed.

The status messages can be read in TROVIS-VIEW 4 in **[Diagnostics > Monitoring]** and the subfolders. The 'Positioner status', 'Valve status', 'Actuator status' and 'Valve position status' messages summarize the status messages of each subfolder and show the summary as a condensed state.

2.1.1 Resetting status messages

After a status message has been generated, the source of the fault must first be located and corrective action taken to remedy it.

Section 17.1 (page 89) lists the recommended corrective action for the status messages.

Status messages can be reset individually or using the reset function. Table 2 (page 13) contains a summary on how to reset the diagnosis data. Status messages are reset in **[Diagnostics > Service/maintenance > Reset]**.

To save measured data and the analysis before resetting the positioner, upload these data onto a PC before performing the reset.

Resetting individual status messages

- Status messages represented by a code on the positioner display can be confirmed at the positioner after selecting the code using the rotary pushbutton. Refer to the Mounting and Operating Instructions EB 8384-6 EN.
- On resetting histograms and graphs, the data for short-term monitoring of these histograms and graphs are also reset.

- Resetting measured data does not cause the diagnostic parameters and reference values to be reset.
- The positioner does not need to be re-initialized after the reset.

Resetting measured diagnostic data

Code 36 - Diag

- Parameters are reset as described in section 17.3.
- The diagnosis is reset.
- Reference values are kept.
- Status classification and logging are kept.
- The positioner does not need to be re-initialized after the reset.

If measured diagnostic data are to be reset regularly, the reset schedule can be entered in *Desired time until 'Reset diagnostic measured data'* (Code 48 - h3). The reset schedule is deactivated when 00:00:00 is set.

Resetting start-up parameters

Code 36 - Std

- Parameters are reset as described in section 17.3.
- The diagnosis is reset.
- Reference values are deleted.
- Status classification is kept.
- Logging is reset.
- The positioner must be re-initialized after the reset.

Resetting to default settings

Code 36 - DS

- Parameters are reset as described in section 17.3.
- The diagnosis is reset.
- Reference values are deleted.
- Status classification and logging are deleted.
- The positioner must be re-initialized after the reset.

Note: *After mounting the positioner on a new control valve, perform a reset by executing* Reset to default settings (Code 36 - DS) *to reset the positioner and then re-initialize the positioner.*

Table 2 · Resetting the test diagnosis

			Individual reset	Code 36		
				Diag	Std	DS
Reference graphs	Valve signature		NO	NO	JA	JA
	Leakage sensor	Manufacturer reference	YES	NO	YES	YES
		Process reference	YES	NO	YES	YES
Data logger	Configuration and measured data		NO	YES	YES	YES
Valve signature	Signal pressure (x)	Measured data	YES	YES	YES	YES
	Course of supply pressure	Configuration	NO	NO	YES	YES
		Measured data	YES	YES	YES	YES
	Friction (x)	Measured data	YES	YES	YES	YES
On/off valve		Configuration	YES	NO	YES	YES
		Measured data	YES	YES	YES	YES
Valve position histogram		Measured data	YES	YES	YES	YES
	Short-term monitoring	*Sampling time* and measured data	YES	YES	YES	YES
Set point deviation histogram		Measured data	YES	YES	YES	YES
	Short-term monitoring	*Sampling time* and measured data	YES	YES	YES	YES
Cycle counter histogram		Measured data	YES	YES	YES	YES
	Short-term monitoring	Measured data	YES	YES	YES	YES
Leakage sensor	Short-term monitoring	*Sensitivity sound level* and measured data	YES	YES	YES	YES
	Long-term monitoring	Measured data	YES	YES	YES	YES
	Sound level (x)	Measured data	YES	YES	YES	YES
Course of lower end position		Measured data	YES	YES	YES	YES
		Reference value	YES	NO	YES	YES
Valve dead band		Configuration and measured data	YES	YES	YES	YES
Partial stroke test (PST)		Configuration and measured data	YES	NO*	YES	YES
		* Except for *Sampling time* parameter				

		Individual reset	Code 36		
			Diag	Std	DS
Full stroke test (FST)	Configuration and measured data	YES	NO*	YES	YES
	* Except for *Sampling time* and *Max. test duration* parameters				
Alarm settings		NO	See section 17.3		
Status classification according to NAMUR Recommendation NE 107		NO	NO	NO	YES
All logging messages (refer to section 2.2)		YES	NO	YES	YES
Operating hours counter		NO	NO	NO	NO
	Device in operation	NO	NO	YES	YES
	Device switched on since initialization	NO	NO	YES	YES
	Device in operation since initialization	NO	NO	YES	YES

Table 3 · Readings of the condensed state

Status message	TROVIS-VIEW 4/DTM	Positioner	Priority
Function check	 orange	Text e.g. ***TESTING***, ***TUNE*** or ***TEST***	
Failure	 red		
Out of specification	 yellow	 blinking	
Maintenance required/ Maintenance demanded	 blue		
No message, OK	 green		

2.1.2 Condensed state

To provide a better overview, the state of the positioner is summarized in a condensed state which is made up from a summary of all classified positioner messages.

The condensed state appears in TROVIS-VIEW 4 on the right-hand side of the info bar, on the start page and in the **Measured process values** folder. See Table 3 for the icons and their meanings.

Additionally, the condensed state can be used to trigger the data logger. Refer to section 3.2.1.

Note: *The condensed state is marked with* ☐ *until it is read out.*

The condensed state can be read on the positioner display under Code 48 - d6. See Table 3.

Condensed state at the fault alarm output

The condensed state is additionally issued at the fault alarm output if one of the following conditions met:

1. 'Failure' is set as the condensed state.
2. 'Function check' is set as the condensed state and is activated at the fault alarm output.
3. 'Maintenance required' is set as the condensed state and is activated at the fault alarm output.
4. 'Out of specification' is set as the condensed state and is activated at the fault alarm output.

Device settings > Alarm settings

2. – Error message in case of 'Function check' condensed state (Code 32): **Yes**

3. – Error message in case of 'Maintenance required' and 'Out of specification' condensed state (Code 33): **Yes**

4. – Error message in case of 'Maintenance required' and 'Out of specification' condensed state (Code 33): **Yes**

2.2 Logging

The last thirty generated messages are saved in the positioner with a time-stamp (logged by the operating hours counter) and details on how long the message exists.

These messages can be read in TROVIS-VIEW 4 in **[Diagnostics – Monitoring – Logging]**.

Logging starts automatically 15 minutes after initialization. It does not need to be activated by the user.

Messages are logged when:

- Their status classification is not 'No message'.
- Their recording in the logging is activated.

The 'Internal solenoid valve/forced venting/supply pressure' message is only additionally logged when the time under *Min. interval for new logging of internal solenoid valve* has elapsed between the generation of two 'Internal solenoid valve/forced venting/supply pressure' messages.

Note: *The logging can only be deactivated when the associated status classification is set to 'No message'.*

Device settings > Alarm settings > Status classification > Logging

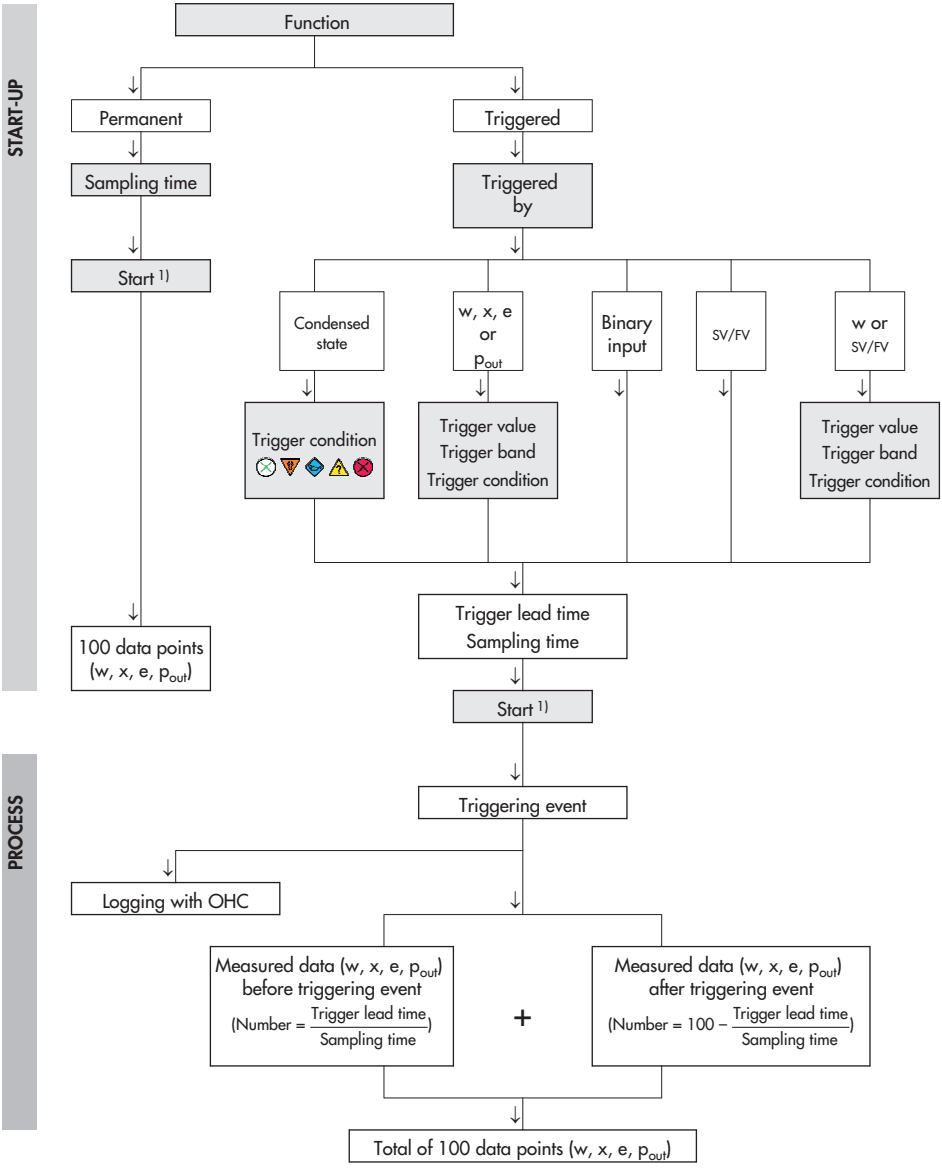
- Supply pressure: [Yes], No
- Friction change: [Yes], No
- Seat leakage: [Yes], No
- Packing leakage: [Yes], No
- Pneumatic leakage: [Yes], No
- Actuator springs defect: [Yes], No
- Manipulated variable range limitation: [Yes], No
- Course of end position: [Yes], No
- Positioner-valve linkage: [Yes], No
- Manipulated variable range: [Yes], No
- Course of manipulated variable range: [Yes], No
- Partial stroke test (PST): [Yes], No
- Full stroke test (FST): [Yes], No
- On/off valve: [Yes], No
- Code 50-58, 61, 63, 76, 81: [Yes], No
- Binary input: [Yes], No
- Data logger: [Yes], No
- Internal solenoid valve/forced venting/supply pressure: Yes, [No]
- Min. interval for new logging of internal solenoid valve: 0 to 5000 s, [300 s]

The following messages are not logged if they are generated due to a hardware error:

- Packing leakage
- Pneumatic leakage
- Manipulated variable range limitation
- Course of end position
- Positioner-valve linkage
- Manipulated variable range
- Course of manipulated variable range

In this case, only the original hardware error is logged:

- x > range (Code 50)
- Initialization/internal solenoid valve/forced venting (Code 54)
- Transit time not reached (Code 55)
- Inconsistent data memory (Code 59)
- Internal device error (Code 60)
- x signal (Code 62)
- i/p converter (Code 64)
- Hardware (Code 65)



1) The data logger is started by the operator software, e.g. TROVIS-VIEW 4

3 Data logger

The data logger records the following variables: *Valve position x, Set point w, Set point deviation e* and *Signal pressure* p_{out}. These data are plotted over time in a graph.

Note: *The data logger is stopped by the following events and must be reactivated:*

- *Operating mode change*
- *Failure of the air supply*
- *Failure of the electrical power supply of the positioner*
- *Failure of the electrical power supply of the external solenoid valve*

3.1 Permanent data logging

The variables are recorded at the predetermined *Sampling time* and saved in the FIFO memory in the positioner with a memory depth of 100 data points per variable.

Note: *The data recorded over the last 24 hours can be read from the* Data logger *graph if the* Data logger *folder in* [Diagnostics] *is kept open during this time.*

Setting this function

1. Select *Permanent* from the drop-down list for *Function*.
2. Set *Sampling time*.
3. Start the data logger.
   The *Test information* reading indicates 'Test active'.

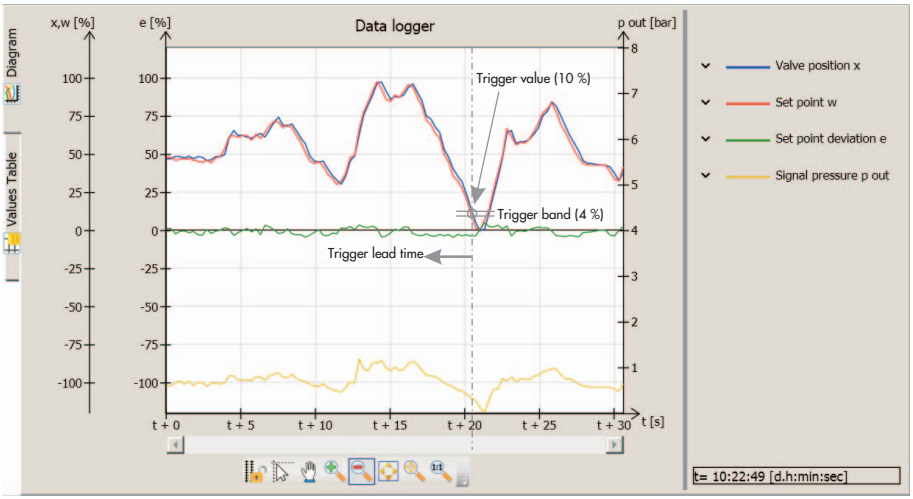


Fig. 1 · Diagnostics > ***Data logger***

Diagnostics > Data logger

1. – Function: **[Permanent]**
2. – Sampling time: 0.2 to 3600.0 s, [1.0 s]
3. – Start data logger

Note: *By executing* Cancel data logger*, the data logger is canceled (*Test information *reading = 'Test not active').*

3.2 Triggered data logging

The data points are saved in the FIFO memory after the event selected in *Triggered by* (refer to sections 3.2.1 to 3.2.5) occurs. The triggering event is logged. The data logging stops as soon as 100 data points per variable are saved in the FIFO memory. The *Sampling time* defines the time between data point logging. A *Trigger lead time* greater than 0 causes the data points which were recorded during this time to be included in the triggered event logging of 100 data points per variable. The *Trigger lead time* can be set to the value 100 x *Sampling time* at the maximum.

Setting this function

1. Select *Triggered* from the drop-down list for *Function*.
2. Select triggering event from the drop-down list.
3. Set *Sampling time*.
4. Start the data logger.
   The *Test information* reading indicates 'Test active'.

   When the data logging is finished, the *Progress* bar indicates 'Memory full, data recording completed'.

Note: *By executing* Cancel data logger*, the data logger is canceled (*Test information *reading = 'Test not active').*

3.2.1 Data logging triggered by condensed state

The data points are included in the triggered event logging when the condensed state selected under the *Trigger condition* is registered.

Note: *When 'Function check' is configured as the triggering condition, data are logged when a dynamic test starts. Each test start is logged.*

Diagnostics > Data logger

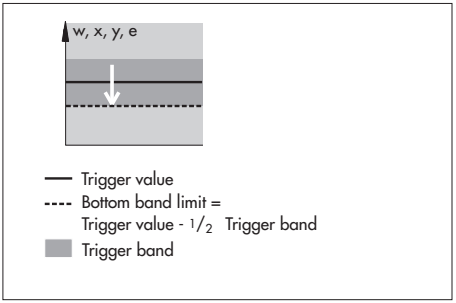
1. – Function: **Triggered**
2. – Sampling time: 0.2 to 3600.0 s, [1.0 s]
3. – Triggered by: **Condensed state**
   – Trigger lead time: 0.0 s to 100 x Sampling time, [20.0 s]
   – Triggered by condensed state: No message, Function check, [Maintenance required], Maintenance demanded, Out of specification, Failure
4. – Start data logger

3.2.2 Data logging triggered by set point, valve position, set point deviation or signal pressure

The data points are included in the triggered event logging when the conditions for the selected variable (*Set point w, Valve position x, Set point deviation e* or *Signal pressure* p_{out}) defined under *Trigger value, Trigger band* and *Trigger condition* are fulfilled.

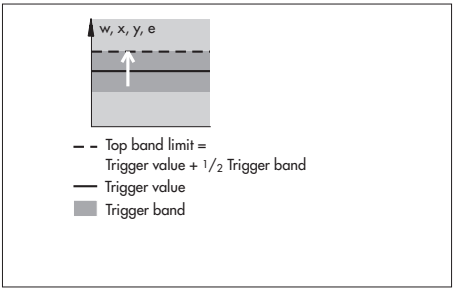
Trigger condition = Decreasing signal/ lower band value undercut

The conditions to start data logging are fulfilled when the limit (*Trigger value* – ½ *Trigger band*) is under cut.



Trigger condition = Increasing signal/upper band value exceeded

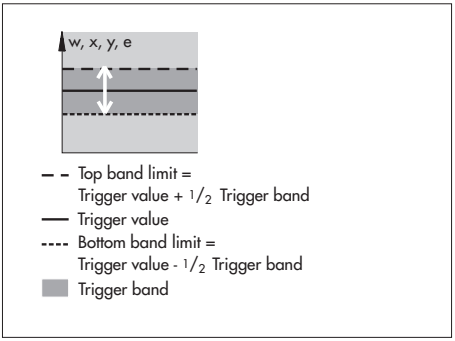
The conditions to start data logging are fulfilled when the limit (*Trigger value* + ½ *Trigger band*) is exceeded.



Trigger condition = Band exit

The conditions to start data logging are fulfilled when the limit (*Trigger value* – ½ *Trigger band*) is under cut or the limit (*Trigger value* + ½ *Trigger band*) is exceeded.

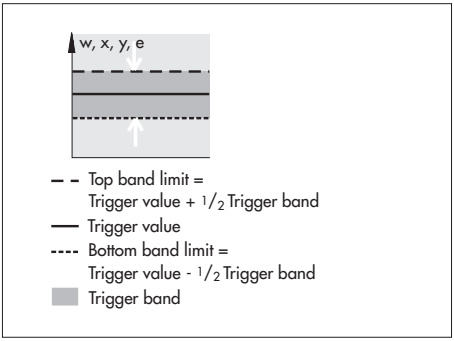
This function is only active when *Trigger band* is ≠ 0.



Trigger condition = Band entry

The conditions to start data logging are fulfilled when the limit (*Trigger value* – ½ *Trigger band*) is exceeded or the limit (*Trigger value* + ½ *Trigger band*) is under cut.

This function is only active when *Trigger band* is ≠ 0.



Diagnostics > Data logger

1. – Function: **Triggered**
2. – Triggered by: **Valve position, Set point deviation, Signal pressure** or **Set point**
   – Trigger value:
   Set point, Valve position, Set point deviation · 0.0 to 100.0 %, [99.0 %]
   Signal pressure · 0.0 to 7000.0 mbar, [99.0 mbar]
   – Trigger band:
   Set point, Valve position, Set point deviation · 0.0 to 100.0 %, [99.0 %]
   Signal pressure · 0.0 to 7000.0 mbar, [99.0 mbar]
   – Trigger lead time: 0.0 s to 100 x Sampling time, [20.0 s]
   – Trigger condition: [Decreasing signal/ lower band value undercut], Increasing signal/upper band value exceeded, Band exit, Band entry
3. – Sampling time: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

3.2.3 Data logging triggered by the binary input

This setting is only active when a binary input is installed in the positioner. Otherwise, the *Progress* bar indicates 'Unable to start data logger – trigger cannot be set'.

The data points are included in the triggered event logging when the state of the binary input changes.

Diagnostics > Data logger

1. – Function: **Triggered**
2. – Triggered by: **Binary input**
   – Trigger lead time: 0.0 s to 100 x Sampling time, [20.0 s]
3. – Sampling time: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

3.2.4 Data logging triggered by the internal solenoid valve/forced venting

This setting is only active when an internal solenoid valve/forced venting is installed in the positioner. Otherwise, the *Progress* bar indicates 'Unable to start data logger – trigger cannot be set'.

The data points are included in the triggered event logging when the solenoid valve is set off/forced venting is activated.

Diagnostics > Data logger

1. – Function: **Triggered**
2. – Triggered by: **Internal solenoid valve/ forced venting**
   – Trigger lead time: 0.0 s to 100 x Sampling time, [20.0 s]
3. – Sampling time: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

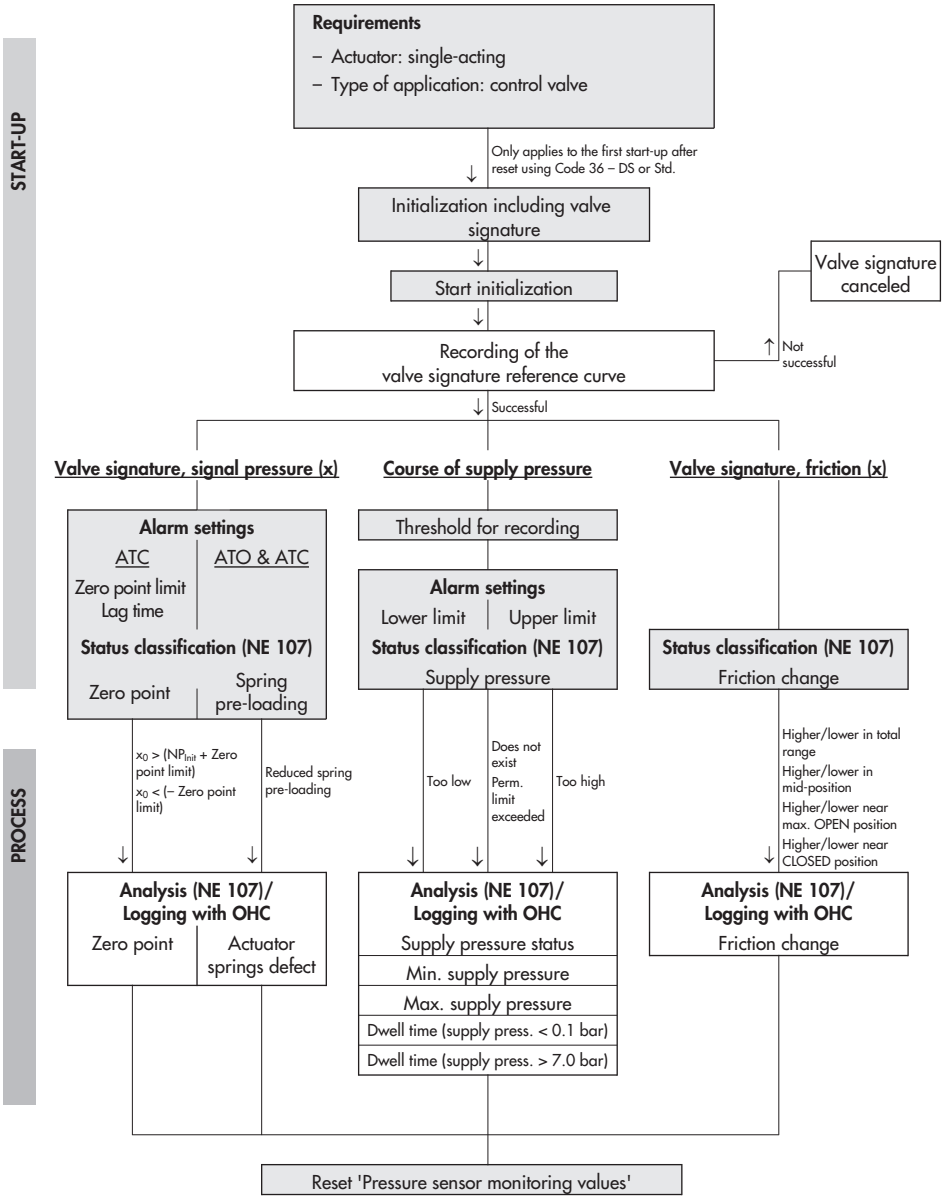
3.2.5 Data logging triggered by set point or the internal solenoid valve/forced venting

This setting is only active when an internal solenoid valve/forced venting is installed in the positioner. Otherwise, the *Progress* bar indicates 'Unable to start data logger – trigger cannot be set'.

When one of the conditions selected under *Triggered by internal solenoid valve/forced venting* or *Triggered by set point* is fulfilled, the data points are included in the triggered event logging.

Diagnostics > Data logger

1. – Function: **Triggered**
   – Triggered by: **Set point or the internal solenoid valve/forced venting**
   – Trigger value: 0.0 to 100.0 %, [99.0 %]
   – Trigger band: 0.0 to 100.0 %, [99.0 %]
   – Trigger lead time: 0.0 s to 100 x Sampling time, [20.0 s]
   – Trigger condition: [Decreasing signal/ lower band value undercut], Increasing signal/upper band value exceeded, Band exit, Band entry
3. – Sampling time: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger


START-UP
PROCESS
Requirements
– Actuator: single-acting
– Type of application: control valve
Only applies to the first start-up after reset using Code 36 – DS or Std.
Initialization including valve signature
Start initialization
Valve signature canceled
Recording of the valve signature reference curve
Not successful
Successful
Valve signature, signal pressure (x)
Course of supply pressure
Valve signature, friction (x)
Alarm settings
ATC
ATO & ATC
Zero point limit
Lag time
Status classification (NE 107)
Zero point
Spring pre-loading
Threshold for recording
Alarm settings
Lower limit
Upper limit
Status classification (NE 107)
Supply pressure
Status classification (NE 107)
Friction change
x0 > (NPInit + Zero point limit)
x0 < (– Zero point limit)
Reduced spring pre-loading
Too low
Does not exist
Perm. limit exceeded
Too high
Higher/lower in total range
Higher/lower in mid-position
Higher/lower near max. OPEN position
Higher/lower near CLOSED position
Analysis (NE 107)/ Logging with OHC
Zero point
Actuator springs defect
Analysis (NE 107)/ Logging with OHC
Supply pressure status
Min. supply pressure
Max. supply pressure
Dwell time (supply press. < 0.1 bar)
Dwell time (supply press. > 7.0 bar)
Analysis (NE 107)/ Logging with OHC
Friction change
Reset 'Pressure sensor monitoring values'

4 Valve signature

The valve signature plots the *Signal pressure* p_{out} as a function of *Valve position x*.

All diagnostic functions dependent on the signal pressure are based on the valve signature, e.g. to detect a pneumatic leakage, to measure the flow rate or to reveal an excessively high or low supply pressure.

***Note:** Additionally, the pneumatic section is monitored using the* Leakage limit *parameter, which is adjustable between 0 and 100 % in the* Alarm settings *subfolder **[Device settings]**. The positioner generates the 'Pneumatic leakage' message whenever the leakage exceeds this limit value. 'No message' is assigned by default.*

Requirements

1. A single-acting actuator is mounted on the valve used.
2. **No** booster is mounted on the valve used.
3. The valve operates as a control valve.

Device settings > Actuator

1. – Principle of operation (Code 48 - d11): **Single-acting**

Start-up

2. – Type of application(Code 49 - h0): **[Control valve]**

To perform the monitoring while the process is running, the reference curve must first be plotted.

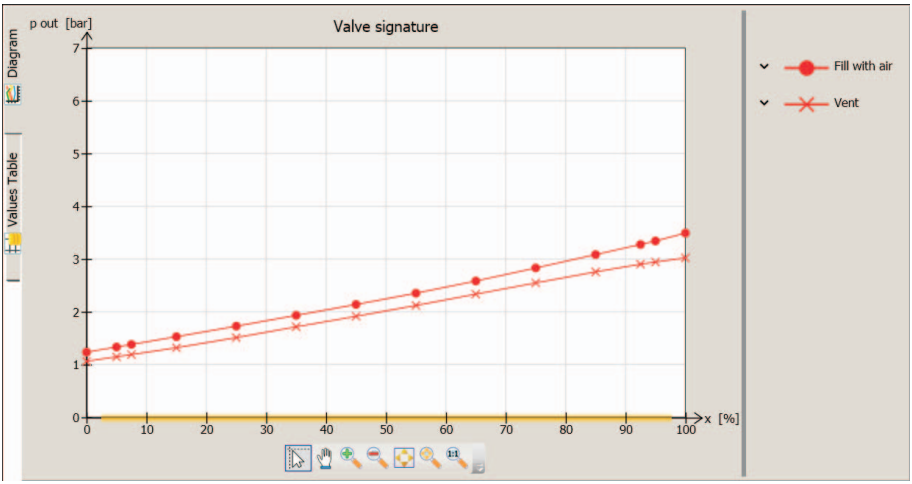


Fig. 2 · Start-up > Reference graphs > ***Valve signature***

4.1 Reference curve

When plotting the reference curve (Fig. 2), the valve is moved very slowly from the end position at which no pressure is applied to the actuator to the position at which the maximum air signal is applied to the actuator. The valve is then moved back again to its end position. During which, the positioner switches to open-loop control (control without feedback).

The user can determine how sensitive the reference curve is to be plotted. Consequently, the valve is moved at the corresponding speed. The time span how long the reference curve is to be plotted depends on the sensitivity selected. Select *High* for valves with small bench ranges and/or high friction.

After the reference curve has been plotted, the recorded data points of *Signal pressure* p_{out} and *Valve position x* are converted into fixed points.

Note: *The valve positions cannot be predicted in open-loop control (control without feedback). The reference curve may differ for the same valve after each logging.*

Setting the function

The reference curve is automatically plotted after initialization when *Initialization including valve signature* is set to *Yes*.

Start-up
– Initialization including valve signature (Code 48 - h0): **[Yes]**

The reference curve can also be plotted separately outside initialization.

1. Switch to manual operating mode.
2. Select *Sensitivity* from the drop-down list.
3. Start test.
   The *Test information* reading indicates 'Test active'. *D1* and *TEST* are indicated in alternating sequence on the positioner display.
   'Function check' is activated as the condensed state.

Start-up
1. – Enter operating mode (Code 0): **Manual**
Start-up > Reference graphs > Valve signature
2. – Sensitivity: Low, [Medium], High
3. – Start test

4.1.1 Analysis and monitoring

The positioner records the data for filling and venting the actuator. It then determines the characteristic values listed below:

- Mean hysteresis: Average hysteresis (average *signal pressure change* Δp_{out} in relation to the spring range)
- Min. hysteresis: Lowest possible hysteresis (minimum *signal pressure change* Δp_{out} in relation to the spring range)
- Max. hysteresis: Highest possible hysteresis (maximum *signal pressure change* Δp_{out} in relation to the spring range)
- Detected lower spring range value: *Signal pressure* p_{out} when the actuator is filled with the minimum amount of air

- Detected upper spring range value: *Signal pressure p_{out}* when the actuator is filled with the maximum amount of air

The 'Valve signature canceled' message is generated if the test is canceled.

Start-up > Initialization result

– Valve signature canceled (Code 81):

The 'Test status' reading indicates the reason why the test was canceled:

- No supply pressure: The supply pressure was under 500 mbar during the test.
- Valve moved too quickly: Recommended action: Increase sensitivity
- Position at p_{max} not reached (filling with air):
  (1) Even though the pressure was increased in steps from 0 bar to the maximum amount of air for filling the actuator, the valve was not able to reach the maximum position in closed-loop operation.
  (2) The minimum valve position without tight-closing is below 96 %.
  Recommended action: Increase supply pressure.
- Position at p_{min} not reached (venting):
  (1) Even though the pressure was reduced in steps from the maximum amount of air for filling the actuator, the valve was not able to reach the minimum position in closed-loop operation. The valve might be jammed.
  (2) The minimum valve position without tight-closing is above 4 %.
- Time-out
- Double-acting actuator
- Internal error
- Current too low
- Internal solenoid valve/forced venting triggered
- Booster connected
- SUB initialization

4.2 Valve signature, signal pressure (x)

The positioner records the data for filling and venting the actuator during closed-loop operation. The recorded data can be directly compared with the reference curve. Additionally, the minimum, maximum and current supply pressure are shown in the graph.

Data are recorded automatically regardless of the operating mode **if a reference curve has already been plotted**. This function does not need to be activated by the user.

Note: *The positioner determines the minimum and maximum supply pressure while plotting the reference curve. The current supply pressure may fall below the minimum supply pressure and exceed the maximum supply pressure.*

Setting the function

1. Record the reference graph. Refer to section 4.1.
2. Set the limit for zero monitoring in control valves with closed position ATC (air to close).
3. Assign status classification to status messages. Refer to section 4.2.1.

Device settings > Alarm settings

2. – Zero point limit (Code 48 - d5): 0.0 to 100.0 %, [5.0 %]
   – Lag time: 1 to 9999 s, [30 s]

3. **Device settings > Alarm settings > Status classification > Positioner**
   – Zero point (Code 58): , [], ,

Device settings > Alarm settings > Status classification > Actuator

Actuator springs defect

– Reduced spring pre-loading: [], , ,

4.2.1 Analysis and monitoring

If the monitoring curve has a smaller gradient than the reference curve, this pinpoints to a reduced compression of the actuator springs.

Diagnostics > Monitoring > Actuator

– Actuator springs defect: , , ,

Valves with ATC (air to close) closed position

In valves with ATC closed position, the positioner generates a zero point error when the valve position in the tight-closing position is larger than the sum of the initialization zero points and 'Zero point limit' or smaller than the negative 'Zero point limit' after the adjusted *Lag time* has elapsed.

Diagnostics > Monitoring > Positioner

– Zero point (Code 58): , , ,

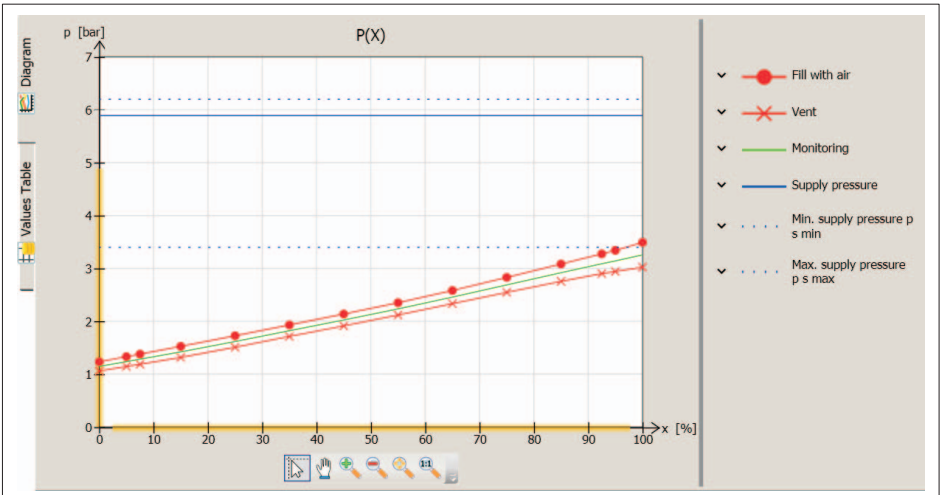


Fig. 3 · Diagnostics > Monitoring/tests > Valve signature > ***Valve signature, signal pressure (x)***

4.3 Course of supply pressure

During control-loop operation, five values of the supply pressure are recorded and saved in a FIFO memory. A new supply pressure is recorded and saved in the memory when it deviates from the last value plotted in the curve by the amount entered in *Threshold for recording*.

Data are recorded automatically regardless of the operating mode adjusted. This function does not need to be activated by the user. **To monitor the limits (*Lower limit* and *Upper limit*), the corresponding limit must be activated first.**

The limits are automatically determined while the valve signature is being plotted. Alternatively, user-defined limits can be entered.

Setting the function

1. Set the *Threshold for recording*.
2. Define limits for monitoring the supply pressure. Refer to section 4.3.1.
3. Assign status classification to status messages. Refer to section 4.3.1.

Diagnostics > Monitoring/tests > Valve signature > Course of supply pressure

1. – Threshold for recording: 0.10 to 14.00 bar, [0.50 bar]

Device settings > Alarm settings

2. – Activate lower limit: [Yes], No
– Lower limit: [0.0] to 7.0 bar
– Activate upper limit: Yes, [No]
– Upper limit: [0.0] to 7.0 bar

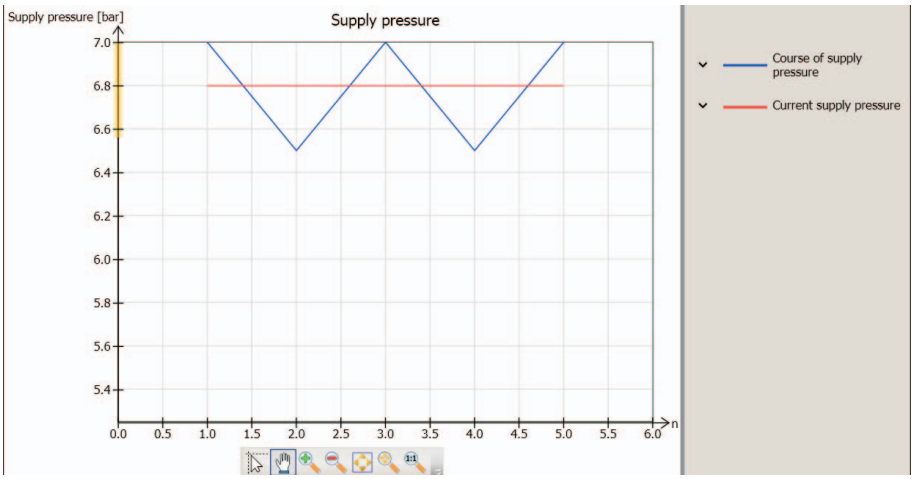


Fig. 4 · Diagnostics > Monitoring/tests > Valve signature > ***Course of supply pressure***

Device settings > Alarm settings > Status classification > Supply pressure

3. – Permissible limit exceeded: , , , [ ]
– Too high: , [ ], ,
– Fluctuates: [ ], , ,
– Too low: , [ ], ,
– Does not exist: , , , [ ]

4.3.1 Analysis and monitoring

The positioner generates the 'Supply pressure status' message with the defined status classification.

- 'Too high' if the supply pressure exceeds the *Upper Limit*.
- 'Does not exist' if the supply pressure falls below 0.1 bar.
- 'Too low' if the supply pressure exceeds the *Lower Limit*.
- 'Permissible limit exceeded' if the supply pressure exceeds 7.0 bar.

A fluctuating supply pressure is recognized by the positioner whenever the supply pressure continuously falls below the *Lower limit* and rises above the *Upper limit*. In such cases, the positioner generates the 'Supply pressure status' message with the defined status classification.

Diagnostics > Monitoring > Actuator

– Supply pressure status: , , ,
– Supply pressure (Code 48 - d7)
– Min. supply pressure
– Time stamp of min. supply pressure
– Max. supply pressure
– Time stamp of max. supply pressure
– Dwell time (supply pressure < 0.1 bar)
– Dwell time (supply pressure > 7.0 bar)

4.4 Valve signature, friction (x)

The positioner calculates the friction during closed-loop operation and compares it with the friction determined when the reference curve was plotted.

Data are recorded automatically 15 minutes after initialization (regardless of the operating mode adjusted) **if a reference curve has already been plotted**. This function does not need to be activated by the user.

Setting the function

1. Record the reference graph. Refer to section 4.1.
2. Assign status classification to status messages. Refer to section 4.2.1.

Device settings > Alarm settings > Status classification > Valve

2. Friction change
- Higher in total range: [⊗], ◆, ⊗, ⚠
- Lower in total range: [⊗], ◆, ⊗, ⚠
- Higher in mid-position: [⊗], ◆, ⊗, ⚠
- Lower in mid-position: [⊗], ◆, ⊗, ⚠
- Higher near max. OPEN position: [⊗], ◆, ⊗, ⚠
- Lower near max. OPEN position: [⊗], ◆, ⊗, ⚠
- Higher near CLOSED position: [⊗], ◆, ⊗, ⚠
- Lower near CLOSED position: [⊗], ◆, ⊗, ⚠

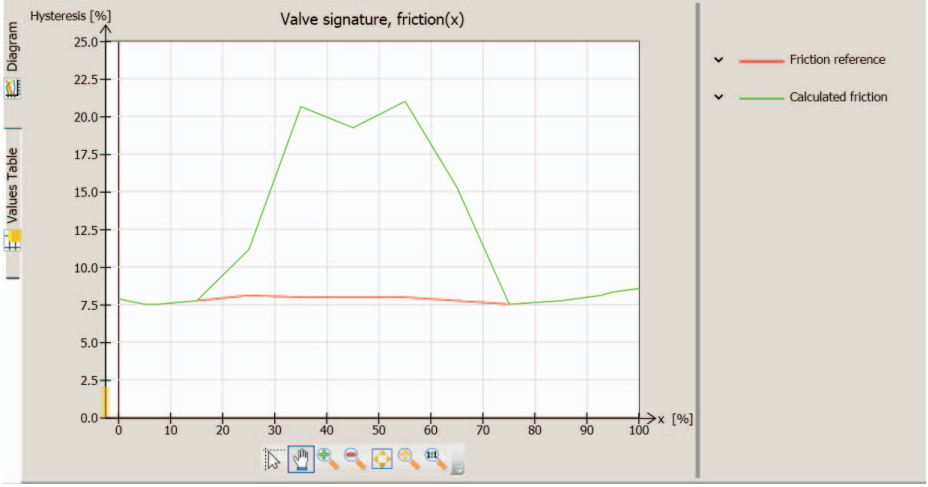


Fig. 5 · Diagnostics > Monitoring/tests > Valve signature > ***Valve signature, friction (x)***

4.4.1 Analysis and monitoring

The positioner generates the 'Friction change' message with the defined status classification when the difference between the calculated friction and the reference friction is at least 5 %. The frictions are compared for the entire valve range, the valve's mid-position and for the ranges near the end positions.

The positioner calculates the friction during closed-loop operation using the actuator filling and venting curve at the point where a directional change in valve travel takes place. The positioner converts the friction data into fixed points close to the point of directional change and compares them to the reference friction.

- If the friction at a fixed point increases to more than double of the reference friction, the friction is regarded to be higher.
- If the friction at a fixed point drops to less than half of the reference friction, the friction is regarded to be lower.

Note: *To ensure that sufficient data points are available for calculating the friction, the valve must not be moved too quickly.*

Diagnostics > Monitoring > Valve

– Friction change: 

4.5 Single reset

All messages generated by the valve signature can be reset together by selecting and executing *Reset 'Pressure sensor monitoring values'*. These messages include:

- Friction change
- Supply pressure status
- Actuator springs defect
- Zero point

At the same time, the supply pressure data (supply pressure, min. supply pressure and max. supply pressure) are reset as well.

Diagnostics > Service/maintenance > Reset

– Reset 'Pressure sensor monitoring values'

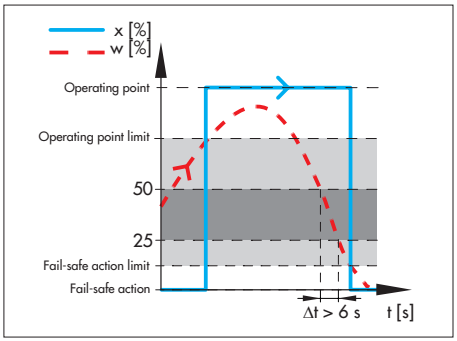
5 On/off valve

The travel range of an on/off valve is defined by the fail-safe position and the predefined operating point. As a result, the following function parameters to determine the operating range and the reference variable range are not evaluated and cannot be changed:

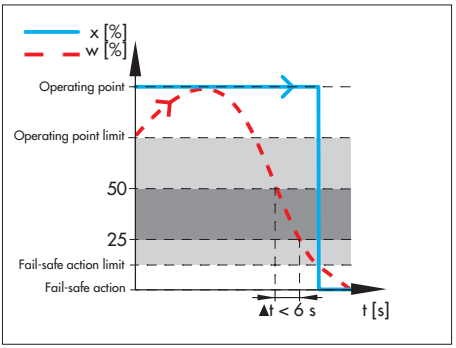
- Lower travel/angle range value
- Upper travel/angle range value
- Lower travel/angle limit
- Upper travel/angle limit
- Set point, lower range value
- Set point, upper range value

In automatic mode, the discrete analysis of the reference variable is performed:

If the reference variable (– – ·) is below the *Operating point limit* when automatic mode starts, the valve (——) moves to the fail-safe position. If the reference variable increases and exceeds the *Operating point limit*, the valve moves to the *Operating point*. The valve moves back to the fail-safe position (0 % in the following example) if the reference variable continues and falls below the *Fail-safe action limit*.

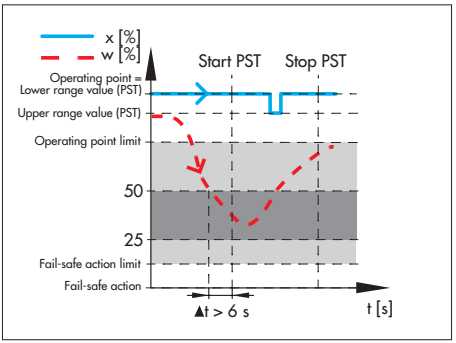


If the reference variable (– – ·) is above the *Operating point limit* when automatic mode starts, the valve (——) moves to the *Operating point*. The valve moves back to the fail-safe position (0 % in the following example) if the reference variable continues and falls below the *Fail-safe action limit*.



Triggering the partial stroke test (PST)

A partial stroke test is started when the reference (– – ·) moves from the *Operating point* into the range between 25 and 50 % travel and remains there for longer than six seconds. Refer to section 12.1 on page 74.



The PST diagnostic parameter *Lower range value* must be within the range of the defined position including ± *Tolerance limit* to allow the partial stroke test to be performed.

After the partial stroke test is completed, the valve moves back to its previous position (fail-safe position or *Operating point*).

Canceling the partial stroke test (PST)

The partial stroke test is canceled whenever the reference variable (– – ·) leaves the range between *Fail-safe action limit* and *Operating point limit*.
After the test has been canceled, the valve moves back to its previous position (fail-safe position or *Operating point*).

Setting the function

Note: *The function can only be set in TROVIS-VIEW 4 after the* Type of application *has been set to* On/off valve.

1. Set *Type of application*.
2. Configure the on/off valve.
3. Configure the partial stroke test (PST). Refer to section 12.

Start-up

1. – Type of application (Code 49 - h0): **On/off valve**

Device settings – Positioner – Transfer characteristic on/off

2. – Operating point (Code 49 - h1): 0.0 to [100 %]
– Fail-safe action limit (Code 49 - h2): 0.0 to 20.0 %, [12.5 %]
– Operating point limit (Code 49 - h5): 55.0 to 100.0 %, [75.0 %]

Diagnostics > Monitoring/tests > Dynamic tests > Partial stroke test (PST)

3. Refer to section 12

5.1 Diagnostics for on/off valve

The diagnostics for on/off valve provide statements on the valve end positions, transit times (increasing/decreasing) and breakaway times (increasing/decreasing).

The data are recorded automatically for the diagnostics for on/off valve in automatic mode. This function does not need to be activated by the user.

While the plant is running, the positioner compares the momentary transit times and breakaway times as well as the momentary travel with the values determined during the reference measurement (first analysis).

Setting the function

Note: *The function can only be set in TROVIS-VIEW 4 after the* Type of application *has been set to* On/off valve.

1. Set the limits for monitoring. Refer to section 5.2.
2. Assign status classification to status messages.

Device settings > Alarm settings

1. – Travel time assessment limit (Code 49 - h7): [0.6] to 30.0 s
   – Valve end position limit (Code 49 - h8): [0.3] to 100.0 %

2. **Device settings > Alarm settings > Status classification > On/off valve**
   – Increasing breakaway time: [ ], , ,
   – Decreasing breakaway time: [ ], , ,
   – Increasing transit time: [ ], , ,
   – Decreasing transit time: [ ], , ,
   – Final travel/angle value not reached: [ ], , ,
   – Increasing final travel/angle value: [ ], , ,
   – Decreasing final travel/angle value: [ ], , ,

5.2 Analysis and monitoring

This analysis pinpoints to an fault whenever at least one of the following conditions is met while the valve moves:

- The momentary *Breakaway time (increasing)* differs from the reference value by the amount entered in *Travel time assessment limit.*
- The momentary *Breakaway time (decreasing)* differs from the reference value by the amount entered in *Travel time assessment limit.*
- The momentary *Transit time (increasing)* differs from the reference value by the amount entered in *Travel time assessment limit.*
- The momentary *Transit time (decreasing)* differs from the reference value by the amount entered in *Travel time assessment limit.*
- The momentary *Valve end position (increasing)* differs from the reference value by the amount entered in *Valve end position limit.*
- The momentary *Valve end position (decreasing)* differs from the reference value by the amount entered in *Valve end position limit.*
- The *Valve end position* is not reached.

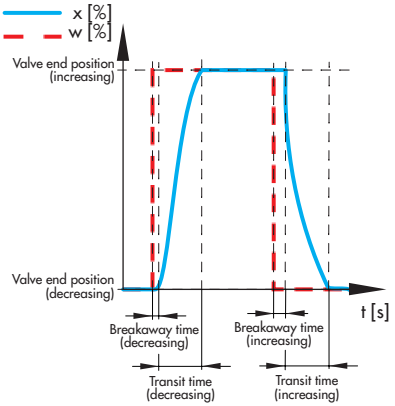


Fig. 6 · Analysis of diagnostics for on/off valve

If one of the conditions is met, the positioner generates the 'On/off valve status' message with the defined status classification.

Diagnostics > Monitoring

– On/off valve status (Code 85): , , ,

5.3 Single reset

The message and the limits can be reset by selecting and executing the command *Reset measured 'On/off valve' values.*

The positioner saves the last two analyses as well as the reference analysis. After performing a further test, the analysis of the last test is deleted.

Diagnostics > Service/maintenance > Reset

– Reset measured 'On/off valve' values

6 Valve position histogram

The valve position histogram is a statistical analysis of the plotted valve positions. The histogram provides information about where the valve mainly spends the majority of its time during its service life and whether it shows a recent trend concerning changes in its operating range.

Data are recorded automatically 15 minutes after initialization (regardless of the operating mode adjusted). This function does not need to be activated by the user.

The positioner records the valve position every second and assigns the data into predefined valve positions classes. The distribution showing how often the valve remained within a class is shown in a bar graph.

- Mean value: Average class assignment of the valve positions over the *Monitoring duration*
- No. of measuring points: Total of data points recorded during the *Monitoring duration*
- Monitoring duration

The data are stored every 24 hours in the positioner's non-volatile memory.

Short-term monitoring

In order to be able to recognize any short-term changes in valve position, the positioner records the valve positions according to the adjusted *Sampling time*. The last 100 measured data points are analyzed.

- Mean value: Average class assignment of the valve positions over the last 100 values
- *Monitoring duration: 100 x Sampling time*

The positioner saves the measured data in a FIFO memory with a memory depth of 100 measured data points.

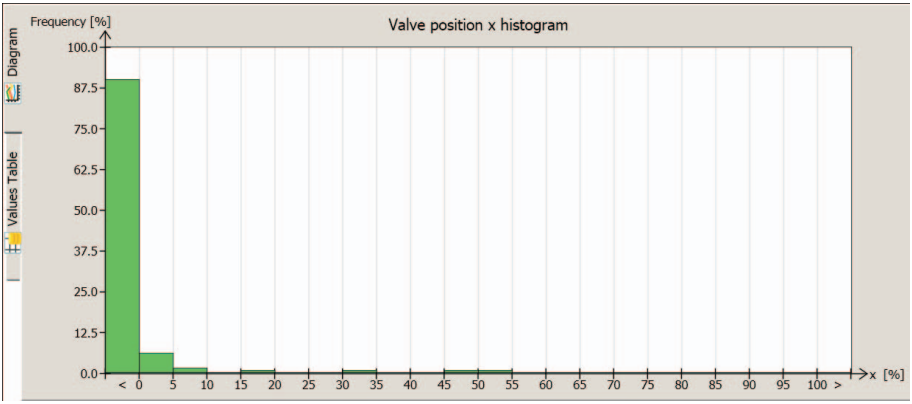


Fig. 7 · Diagnostics > Monitoring/tests > Histograms > ***Valve position histogram***

Note: *Changing the* Sampling time *causes all existing data points to be deleted from the FIFO memory.*

Setting the function

1. Set the *Sampling time* for the short-term monitoring.
2. Assign status classification to status messages. Refer to section 6.1.

Diagnostics > Monitoring/tests > Histograms > Valve position x histogram > Short-term monitoring

1. – Sampling time: Adjustable as required [00:14:24 d.h:min:s]

Device settings > Alarm settings > Status classification > Valve position

2. Manipulated variable range

– Mainly near CLOSED position [⊗], ◈, ⊗, ⚠
– Mainly near max. OPEN position [⊗], ◈, ⊗, ⚠
– Mainly in CLOSED position [⊗], ◈, ⊗, ⚠
– Mainly at max. OPEN position [⊗], ◈, ⊗, ⚠

Course of manipulated variable range

– Operating range shifted to CLOSED position [⊗], ◈, ⊗, ⚠
– Operating range shifted to max. OPEN position [⊗], ◈, ⊗, ⚠
– Short-term change [⊗], ◈, ⊗, ⚠

6.1 Analysis and monitoring

The histogram analysis starts after a monitoring duration of one hour for control valves. No analysis is performed for on/off valves.

If the control valve mainly works during the monitoring duration near or in one of the end positions, the positioner generates the 'Manipulated variable range' message with the defined status classification.

For analysis of the short-term monitoring, a complete set of data (100 data points) is required. The analysis is only active when the sampling time setting is greater or equal to one minute.

The positioner generates the 'Course of manipulated variable range' message with the defined status classification whenever a trend showing a change in the manipulated variable range is found from the analysis of the histogram and the short-term monitoring.

Diagnostics > Monitoring > Valve position

– Manipulated variable range: ☑, ◈, ⊗, ⚠
– Course of manipulated variable range: ☑, ◈, ⊗, ⚠

6.2 Single reset

The 'Manipulated variable range' and the 'Course of manipulated variable range' messages can be reset by selecting and executing the command *Reset 'Short-term valve position x histogram'*. This command resets all diagnostic parameters and measured

data of the histogram and the short-term monitoring.

By selecting and executing the command *Reset 'Valve position x histogram',* the diagnostic parameters and measured data in the Short-term monitoring folder are reset.

Diagnostics > Service/maintenance > Reset

– Reset 'Valve position x histogram'
– Reset 'Short-term valve position x histogram'

7 Set point deviation histogram

The set point deviation histogram contains a statistical analysis of any deviations in the set point (errors). This provides a summary of how often and to which level a set point deviation has occurred during the valve service life and whether malfunctions may arise due to the manipulated variable range limitation or seat leakage.

Data are recorded automatically 15 minutes after initialization (regardless of the operating mode adjusted). This function does not need to be activated by the user.

The positioner records the set point deviation every second and assigns the data into predefined classes. The distribution of how often the set point deviation remained within a class is shown in a bar graph.

- Mean value: Average class assignment of the set point deviation over the *Monitoring duration*
- Number of averages: Total of data points recorded during the *Monitoring duration*
- *Monitoring duration*

The data are stored every 24 hours in the positioner's non-volatile memory.

Short-term monitoring

In order to be able to recognize any short-term changes in set point deviation, the positioner records the set point deviations according to the adjusted *Sampling time*. The last 100 data points are analyzed.

- Mean value: Average class assignment of the valve positions over the last 100 values
- Monitoring duration: 100 x *Sampling time*

The positioner saves the measured data in a FIFO memory with a memory depth of 100 measured data points.

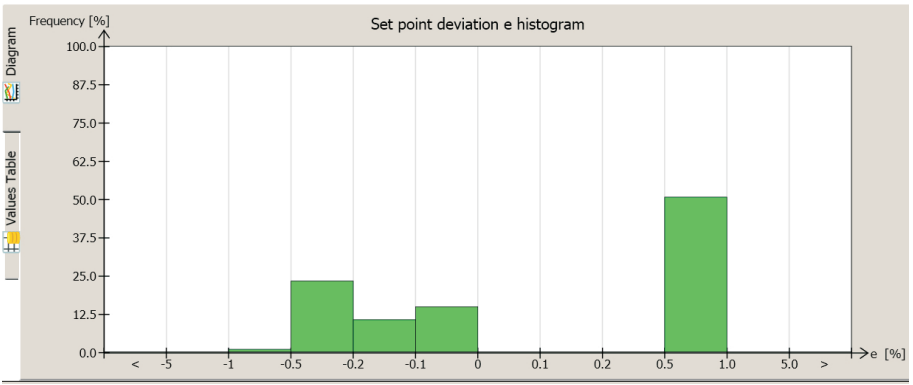


Fig. 8 · Diagnostics > Monitoring/tests > Histograms > ***Set point deviation histogram***

Note: *Changing the* Sampling time *causes all existing data points to be deleted from the FIFO memory.*

Setting the function

1. Set the *Sampling time* for the short-term monitoring.
2. Assign status classification to status messages. Refer to section 7.1.

Diagnostics > Monitoring/tests > Histograms > Set point deviation e histogram > Short-term monitoring

1. – Sampling time: Adjustable as required [00:14:24 d.h:min:s]

Device settings > Alarm settings > Status classification > Valve

2. Seat leakage

– May exist: [⊗], ◈, ⊗, ⚠

Device settings > Alarm settings > Status classification > Valve position

Manipulated variable range limitation

– Lower: [⊗], ◈, ⊗, ⚠
– Upper: [⊗], ◈, ⊗, ⚠
– No change possible: [⊗], ◈, ⊗, ⚠

Positioner-valve linkage

– Travel transmission not optimal: [⊗], ◈, ⊗, ⚠

7.1 Analysis and monitoring

Ideally, the set point deviation should be near 0 %.

Set point deviations greater than 1 % following in quick succession pinpoint to a limitation of the lower manipulated variable range and seat leakage. In this case, the positioner generates the 'Manipulated variable range limitation', 'Positioner-valve linkage' and 'Seat leakage' messages with the defined status classification.

Set point deviations smaller than 1 % following in quick succession pinpoint to a limitation of the upper manipulated variable range. In this case, the positioner generates the 'Manipulated variable range limitation' and 'Positioner-valve linkage' messages with the defined status classification.

If almost set point deviations during the short-term monitoring are larger than 1 % or smaller than –1 %, this is an indication that the actuator or valve stem gets jammed. The positioner generates the 'Manipulated variable range limitation', 'Positioner-valve linkage' and 'Seat leakage' messages with the defined status classification.

Diagnostics > Monitoring > Valve

– Seat leakage: ☑, ◈, ⊗, ⚠

Diagnostics > Monitoring > Valve position

– Manipulated variable range limitation: ☑, ◈, ⊗, ⚠
– Positioner-valve linkage: ☑, ◈, ⊗, ⚠

7.2 Single reset

The 'Manipulated variable range limitation', 'Positioner-valve linkage' and 'Seat leakage' messages can be reset by selecting and executing the command *Reset 'Set point deviation e histogram'* or *Reset 'Short-term set point deviation e histogram'*.

The *Reset 'Set point deviation e histogram'* command resets all diagnostic parameters and measured data of the histogram and the short-term monitoring.

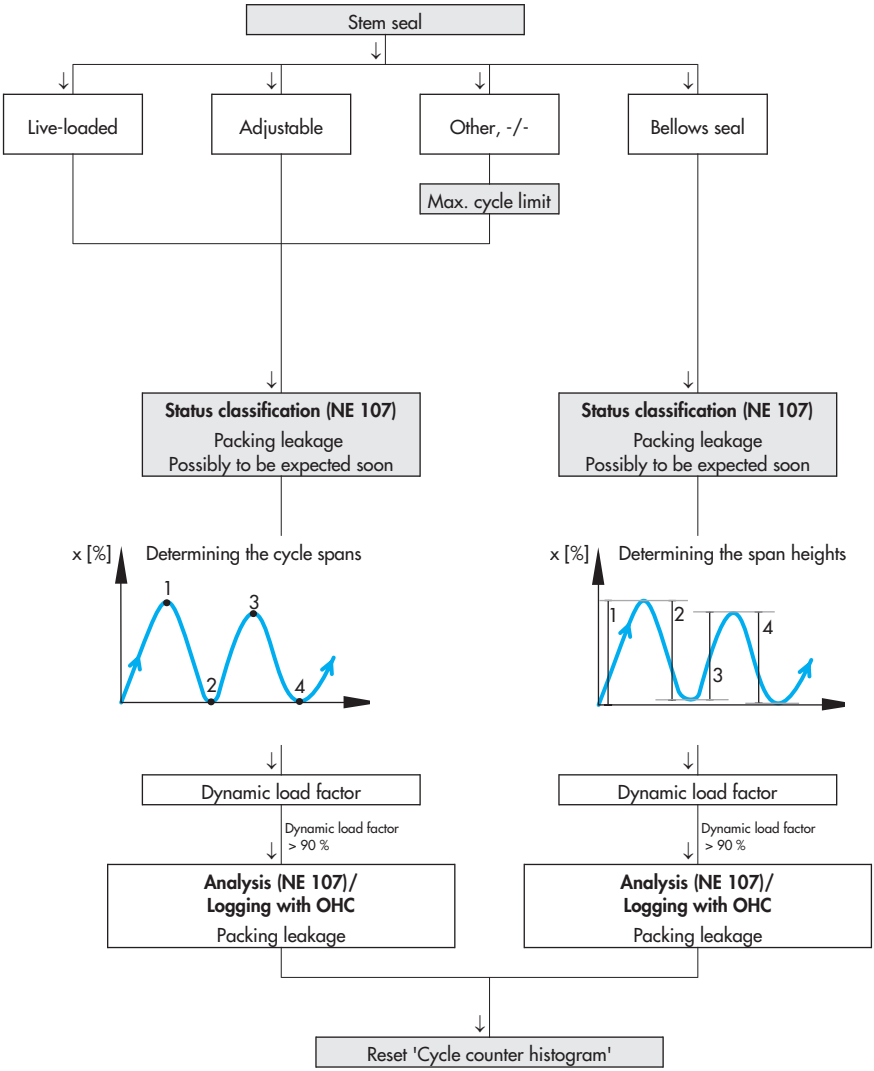
By selecting and executing the command *Reset 'Short-term set point deviation e histogram',* the diagnostic parameters and measured data in the Short-term monitoring folder are reset.

Diagnostics > Service/maintenance > Reset

- Reset 'Set point deviation e histogram'
- Reset 'Short-term set point deviation e histogram'

START-UP

PROCESS



8 Cycle counter histogram

The cycle counter histogram provides a statistical analysis of the cycle span or cycle height. As a result, the cycle counter also provides information on the dynamic stress of a bellows seal and/or packing.

Data are recorded automatically 15 minutes after initialization (regardless of the operating mode adjusted). This function does not need to be activated by the user.

The positioner records the number of cycles when the stem seal setting is set to *Live-loaded*, *Adjustable*, *Other* or *-/-*. A valve cycle starts at the point where the valve stroke changes direction until the point where it changes direction again. The valve stroke between these two changes in direction is the cycle span.

The positioner records the span height when the stem seal setting is set to *Bellows seal*. The span height is the travel between two changes in direction.

The cycle spans or span heights are assigned to classes. The calculated percentages on how often a cycle occurs within a class are shown as a bar graph.

- Mean value: Average class assignment of span heights over the *No. of cycles*
- No. of cycles

The data are stored every 24 hours in the positioner's non-volatile memory.

Setting the function

1. Select the type of stem seal. (*Additionally the *Max. cycle limit* parameter must be set when *Other* is selected as the stem seal)

Device settings > Alarm settings	
1.	– Stem seal: [-/-], Live-loaded, Adjustable, Bellows seal, Other
*	– Max. cycle limit: 1 to 1000000000, [1000000]

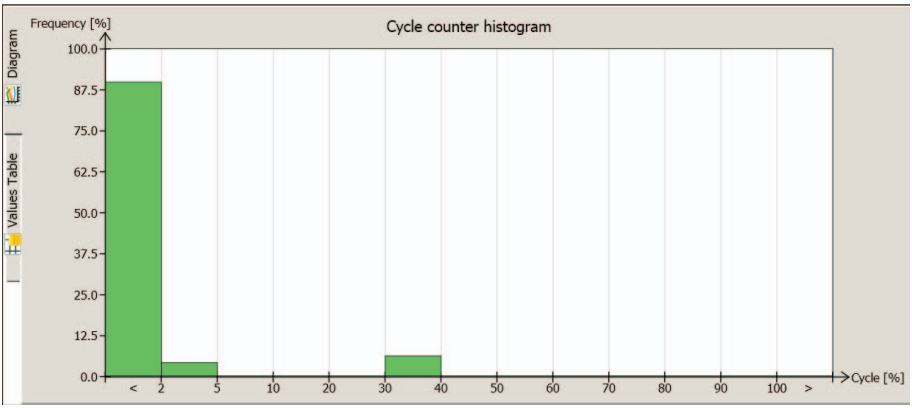


Fig. 9 · Diagnostics > Monitoring/tests > Histogram > ***Cycle counter histogram***

Short-term monitoring

To recognize short-term changes in the cycle spans or cycle heights, the positioner analyzes the last 100 span heights or cycle heights.

The positioner saves the cycle spans or cycle heights in a FIFO memory with a memory depth of 100 measured data points.

- Mean value: Average class assignment of span heights or cycle heights over the last 100 data points

Setting the function

1. Assign status classification to status message.

Device settings > Alarm settings > Status classification > Valve

1. Packing leakage

– Possibly to be expected soon: [],  ,  , 

8.1 Analysis and monitoring

The load on the bellows and/or packing can be read from the *Dynamic load factor* parameter. The value is determined from the cycle spans or cycle heights and takes into account the type of packing used in the valve.

A 'Packing leakage' message is generated with the defined status classification whenever:

- The number of measured cycle spans exceeds 450000 when *Live-loaded* is selected as the stem seal.
- The number of measured cycle spans exceeds 180000 when *Adjustable* is selected as the stem seal.
- The number of measured cycle spans exceeds 90 % of the *Max. cycle limit* when Other is selected as the stem seal.
- The number of measured cycle heights exceeds 180000 when *Bellows seal* is selected as the stem seal.

Measured process values

– Dynamic load factor

Diagnostics > Monitoring > Valve

– Packing leakage: , , ,

8.2 Single reset

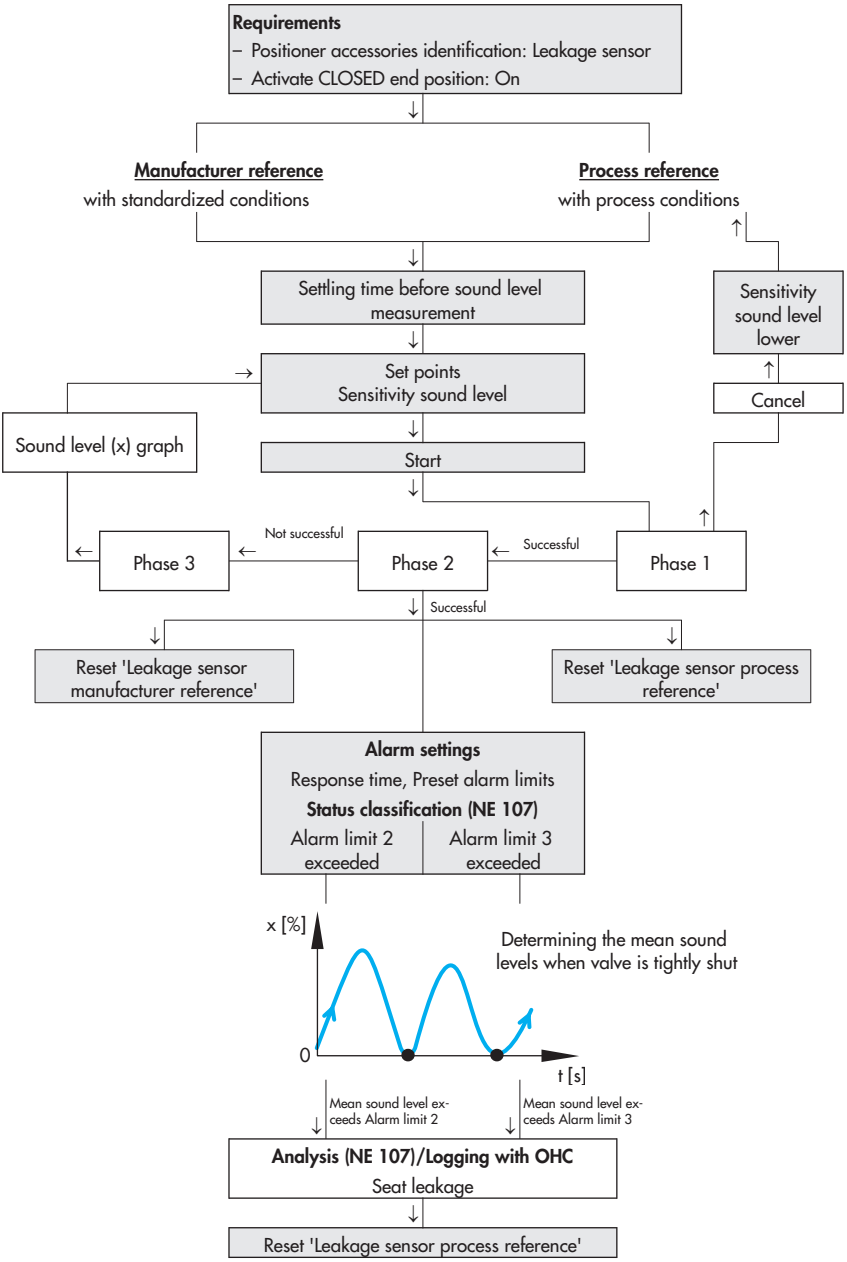
The Packing leakage' message can be reset by selecting and executing the command *Reset 'Cycle counter histogram'* or *Reset 'Short-term cycle counter histogram'*.

The *Reset 'Cycle counter histogram'* command resets all measured data of the histogram, short-term monitoring and the *Dynamic load factor*.

By selecting and executing the command *Reset 'Short-term cycle counter histogram',* the measured data in the Short-term monitoring folder are reset.

Diagnostics > Service/maintenance > Reset

– Reset 'Cycle counter histogram'
– Reset 'Short-term cycle counter histogram'


Requirements
– Positioner accessories identification: Leakage sensor
– Activate CLOSED end position: On
Manufacturer reference
with standardized conditions
Process reference
with process conditions
Settling time before sound level measurement
Sensitivity sound level lower
Set points
Sensitivity sound level
Cancel
Sound level (x) graph
Start
Phase 3
Not successful
Phase 2
Successful
Phase 1
Successful
Reset 'Leakage sensor manufacturer reference'
Reset 'Leakage sensor process reference'
Alarm settings
Response time, Preset alarm limits
Status classification (NE 107)
Alarm limit 2 exceeded
Alarm limit 3 exceeded
x [%]
0
t [s]
Determining the mean sound levels when valve is tightly shut
Mean sound level exceeds Alarm limit 2
Mean sound level exceeds Alarm limit 3
Analysis (NE 107)/Logging with OHC
Seat leakage
Reset 'Leakage sensor process reference'

9 Leakage sensor

By upgrading the positioner with a leakage sensor, it is possible to detect seat leakage when the valve is in the closed position. To achieve this, the leakage sensor measures the sound pressure level (dB) while the valve is tightly shut and compares the current sound pressure level with predefined alarm limits. The positioner generates a message if the current sound pressure level exceeds one of the alarm limits.

Requirements for using the seat leakage detection:

1. A leakage sensor is attached to the valve. Refer to standard Mounting and Operating Instructions EB 8384-6 EN.
2. The leakage sensor option has been selected.
3. The tight-closing function has been activated.
4. The leakage sensor has been put into operation. Refer to section 9.1.

Start-up > Reference graphs > Leakage sensor

2. – Positioner accessories identification: **Leakage sensor**

Device settings > Positioner > Transfer characteristic or Transfer characteristic on/off

3. – Activate CLOSED end position (Code 14): **On**
– CLOSED end position (Code 14): 0.0 to 49.9 %, [1.0 %]

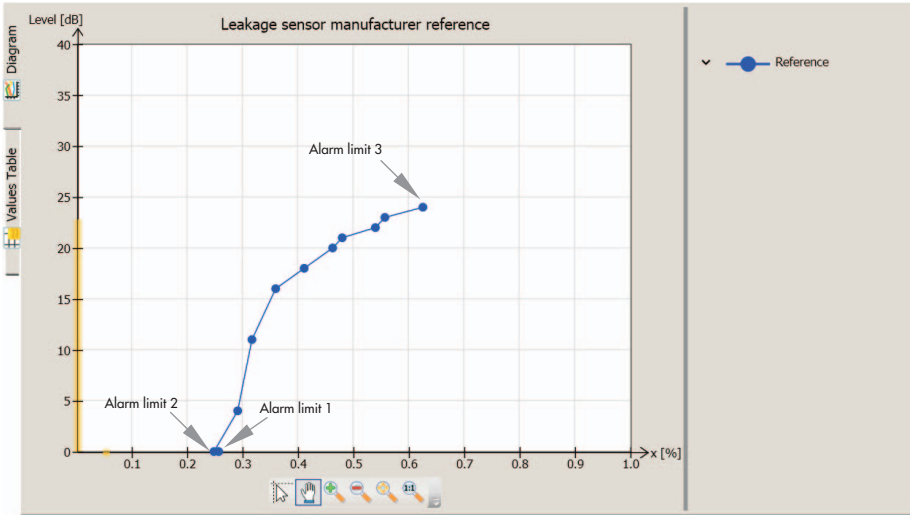


Fig. 10 · Start-up > Reference graphs > Leakage sensor > ***Manufacturer reference***

9.1 Start-up of the leakage sensor

To be able to use the full scope of functions, the response of the leakage sensor to standardized conditions and to the prevailing process conditions must be measured. Furthermore, the limit to activate the alarm must be entered.

9.1.1 Manufacturer reference

Usually, the control valve is delivered with positioner and leakage sensor already mounted. In this case, the reference test has already been performed at the manufacturer's. It does not need to be performed again.

The manufacturer reference test (Fig. 10) measures the response of the leakage sensor to standardized conditions. When the reference test is performed at SAMSON, the standardized conditions are:

- Medium = air
- Inlet pressure = 4 bar
- Outlet pressure = atmosphere

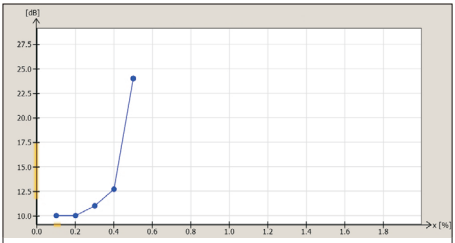
If the leakage sensor has been fitted later onto the valve, the manufacturer reference must be performed before using the leakage sensor.

While the manufacturer reference is running, the parameters listed below are automatically deactivated:

- Activate CLOSED end position
- Activate ramp function

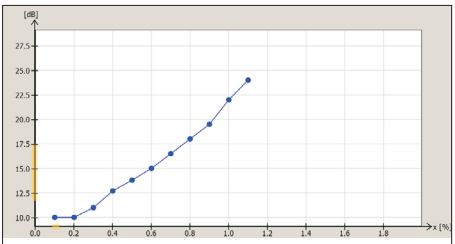
Phase 1: The valve moves to eleven defined set points one after the other. After reaching a set point and after the *Settling time before sound level measurement* has elapsed, the leakage sensor measures the sound pressure level.

If the difference between two neighboring points is larger or equal to the adjusted *Sensitivity sound level*, the valve does not move to the next points. Instead, Phase 2 starts.



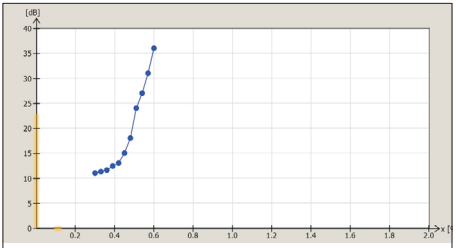
Phase 1 successful: The sound pressure level exceeded the adjusted *Sensitivity sound level* (10 dB) between point 3 and 4. Phase 2 starts

If the *Sensitivity sound level* is not reached after the valve has moved to all eleven set points, the test is canceled. The canceled test is logged with a time stamp. The *Test information* reading indicates 'Test failed: sound level change too low'.



Phase 1 not successful:
The sound pressure level did not reach the adjusted *Sensitivity sound level* (10 dB) between the first and last points. The manufacturer's reference test is canceled.

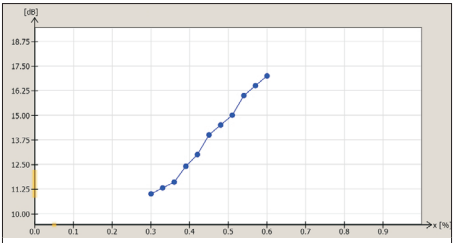
Phase 2: A 0.30 % band is placed around the last set point that the valve moved to. One third of this band lies in front of the set point that the valve moved to and two thirds of the band lies behind it. The band itself is subdivided into eleven fixed points. Each fixed point is located at a distance of 0.03 % to the next point. The valve moves to the new fixed points one after the other. After reaching a fixed point and after the *Settling time before sound level measurement* has elapsed, the leakage sensor measures the sound pressure level.
The manufacturer's reference test is successful when the difference between the first and last fixed points is larger or equal to the adjusted *Sensitivity sound level*.



Phase 2 successful:
The sound pressure level reaches the adjusted *Sensitivity sound level* (10 dB) between the first and last points.
The manufacturer's reference test is successfully completed.

If the *Sensitivity sound level* is not reached after the valve has moved to all eleven fixed points, then the change in sound pressure level is too low. In this case, phase 3 starts.

Phase 3: The valve moves to the set points valid for phase 1 one after the other. This is plotted in a sound level vs. travel graph. The graph shows where the point of activation is and to which value the *Sensitivity sound level* must be reduced to allow the test to be completed successfully.



Phase 2 not successful:
The sound pressure level did not reach the adjusted *Sensitivity sound level* (10 dB) between the first and last points. Phase 3 starts.

Setting the function

Note: *The function can only be set in TROVIS-VIEW 4 after the* Positioner accessories identification *has been set to* Leakage sensor.

1. Switch to manual operating mode.
2. Configure manufacturer reference. Refer to Note concerning editing set points.
3. Start manufacturer reference.
   The start of the reference measurement is documented in the *Time stamp*.
   D8 and *TEST* are indicated in alternating sequence on the positioner display.

Start-up

1. – Enter operating mode (Code 0): **Manual**

Start-up > Reference graphs > Leakage sensor > Manufacturer reference

2. – Settling time before sound level measurement: 1 to 255 s, [5 s]
– Sensitivity sound level: 3 to 255 dB, [10 dB]
– Edit set points: 0.00 to 100.00 % [1: 0.00 %; 2: 0.10 %; 3: 0.20 %; 4: 0.30 %; 5: 0.40 %; 6: 0.50 %; 7: 0.60 %; 8: 0.70 %; 9: 0.80 %; 10: 0.90 %, 11: 1.00 %]

3. – Start manufacturer reference

Note: *By selecting and executing* Cancel manufacturer reference *or by pressing the rotary pushbutton, the manufacturer reference is canceled (*Test information *= 'Test canceled manually'). After canceling the manufacturer reference, the positioner remains in the manual mode.*

In TROVIS-VIEW 4 the test information and progress of the manufacturer reference are displayed. When the manufacturer reference has been successfully completed, the *Test information* reading indicates 'Test completed successfully'.

Note concerning editing set points

- The adjusted set points must steadily increase from *Set point 1* to *Set point 11*.
- The valve moves to the set points in steps of 0.1 %. Set points must be rounded up to two decimal places.
- User-defined settings can be saved for other functions in a file.

9.1.1.1 Analysis

While the manufacturer reference test is running, the positioner determines three alarm limits. The relation between *Valve position x* [%] and *Sound level* [dB] is shown in TROVIS-VIEW 4:

- Relation 1: Valve position and sound level at 0 % position
- Relation 2: Valve position and sound level at the point where the curve in the *Leakage sensor manufacturer reference* graph starts to rise monotonously
- Relation 3: Valve position and sound level at the last measurement

9.1.1.2 Single reset

The manufacturer reference (parameters, measured data and analysis) can be reset by selecting and executing the command *Reset 'Leakage sensor manufacturer reference'*.

If the test is restarted when the manufacturer reference already exists, the analysis of the existing manufacturer reference is overwritten.

Diagnostics > Service/maintenance > Reset

– Reset 'Leakage sensor manufacturer reference'

9.1.2 Process reference

The process reference (Fig. 11) measures the response of the leakage sensor to process conditions. Process medium, inlet and outlet pressures as well as the process environment can have an effect on the sensor's response. The alarm limits are determined from the measured data.

The process reference is performed and analyzed in the same manner as the manufacturer reference described in section 9.1.1. This test must be performed after the valve has been installed and the plant has been commissioned.

If it is not possible to perform the process reference, the user-defined alarm limits can be entered. Refer to section 9.1.2.2.

While the process reference is running, the parameters listed below are automatically deactivated:

- Activate CLOSED end position
- Activate ramp function

Phase 1: The valve moves to eleven defined set points one after the other. After reaching a set point and after the *Settling time before sound level measurement* has elapsed, the leakage sensor measures the sound pressure level.

If the difference between two neighboring points is larger or equal to the adjusted *Sensitivity sound level*, the valve does not move to the next points. Instead, Phase 2 starts.

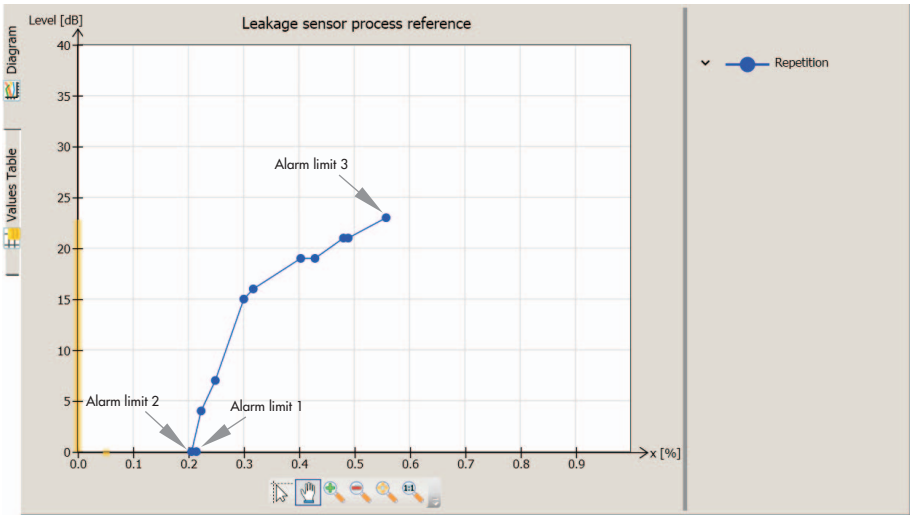
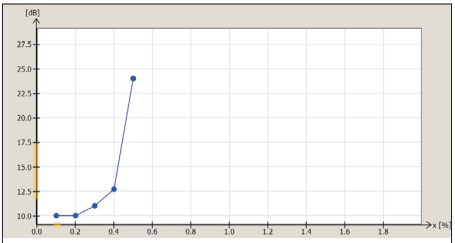
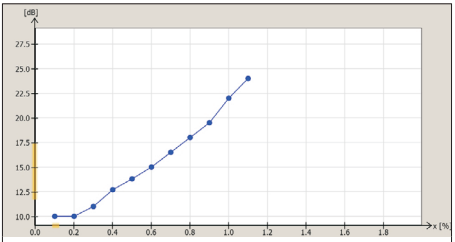


Fig. 11 · Start-up > Reference graphs > Leakage sensor > ***Process reference***



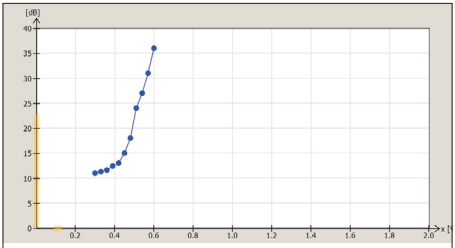
Phase 1 successful: The sound pressure level exceeded the adjusted *Sensitivity sound level* (10 dB) between point 3 and 4. Phase 2 starts

If the *Sensitivity sound level* is not reached after the valve has moved to all eleven set points, the test is canceled. The canceled test is logged with a time stamp. The *Test information* reading indicates 'Test failed: sound level change too low'.



Phase 1 not successful:
The sound pressure level did not reach the adjusted *Sensitivity sound level* (10 dB) between the first and last points. The process reference test is canceled.

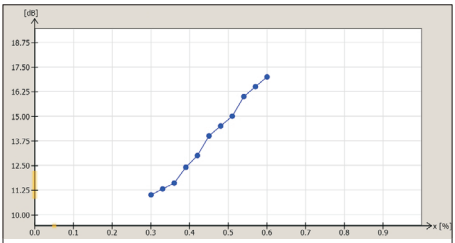
Phase 2: A 0.30 % band is placed around the last set point that the valve moved to. One third of this band lies in front of the set point that the valve moved to and two thirds of the band lies behind it. The band itself is subdivided into eleven fixed points. Each fixed point is located at a distance of 0.03 % to the next point. The valve moves to the new fixed points one after the other. After reaching a fixed point and after the *Settling time before sound level measurement* has elapsed, the leakage sensor measures the sound pressure level.



Phase 2 successful:
The sound pressure level reaches the adjusted *Sensitivity sound level* (10 dB) between the first and last points.
The process reference test is successfully completed.

The process reference test is successful when the difference between the first and last fixed points is larger or equal to the adjusted *Sensitivity sound level*.

If the *Sensitivity sound level* is not reached after the valve has moved to all eleven fixed points, then the change in sound pressure level is too low. In this case, phase 3 starts.



Phase 2 not successful:
The sound pressure level did not reach the adjusted *Sensitivity sound level* (10 dB) between the first and last points. Phase 3 starts.

Phase 3: The valve moves to the set points valid for phase 1 one after the other. This is plotted in a sound level vs. travel graph. The graph shows where the point of activation is and to which value the *Sensitivity sound level* must be reduced to allow the test to be completed successfully.

Setting the function

Note: *The function can only be set in TROVIS-VIEW 4 after the* Positioner accessories identification *has been set to* Leakage sensor.

1. Switch to manual operating mode (Code 0 = MAN).
2. Configure process reference. Refer to Note concerning editing set points.
3. Start process reference.
   The start of the reference measurement is documented in the *Time stamp*.
   D9 and *TEST* are indicated in alternating sequence on the positioner display.

Start-up

1. – Enter operating mode (Code 0): **Manual**

Start-up > Reference graphs > Leakage sensor > Process reference

2. – Settling time before sound level measurement: 1 to 255 s, [5 s]
– Sensitivity sound level: 3 to 255 dB, [10 dB]
– Edit set points: 0.00 to 100.00 % [1: 0.00 %; 2: 0.10 %; 3: 0.20 %; 4: 0.03 %; 5: 0.04 %; 6: 0.05 %; 7: 0.06 %; 8: 0.07 %; 9: 0.08 %; 10: 0.09 %, 11: 1.00 %]

3. – Start process reference

Note: *By selecting and executing* Cancel process reference *or by pressing the rotary pushbutton, the process reference is canceled (*Test information *= 'Test canceled manually'). After canceling the process reference, the positioner remains in the manual mode.*

In TROVIS-VIEW 4 the test information and progress of the process reference are displayed. When the process reference has been successfully completed, the *Test information* reading indicates 'Test completed successfully'.

Note concerning editing set points

- The adjusted set points must steadily increase from *Set point 1* to *Set point 11*.
- The valve moves to the set points in steps of 0.1 %. Set points must be rounded up to two decimal places.
- User-defined settings can be saved for other functions (e.g. repetition test) in a file.

9.1.2.1 Analysis

While the process reference test is running, the positioner determines three alarm limits. The relation between *Valve position x* [%] and *Sound level* [dB] is shown in TROVIS-VIEW 4:

- Relation 1: Valve position and sound level at 0 % position
- Relation 2: Valve position and sound level at the point where the curve in the

Leakage sensor process reference graph starts to rise monotonously

- Relation 3: Valve position and sound level at the last measurement

9.1.2.2 Alarm settings

After connecting the leakage sensor and performing the manufacturer and process reference tests, the positioner can pinpoint any seat leakage. To do this, it records the sound level in closed-loop operation while the valve is tightly shut. The seat leakage monitoring is performed automatically while the process is running.

The alarm limits detected in the manufacturer reference test, process reference test or user-defined settings can be selected. When user-defined limits are entered, the alarm limits must rise continuously from *Alarm limit 1* to *Alarm limit 3*.

During closed-loop operation, the mean sound levels while the valve is tightly shut are compared to the alarm limits. Which mean sound level is to be used for comparison can be selected in *Response time:*

- **Very quick:** The mean value calculated from the current sound level and from the last four sound levels measured while the valve is tightly shut is used for monitoring (Fig. 12: Tight-closing event 31 and sound level E to I).
- **Quick:** The mean value calculated from all sound levels measured while the valve is tightly shut is used for monitoring (Fig. 12: Tight-closing event 31 and sound level A to I).
- **Slow:** The mean value calculated from the last thirty sound levels measured during short-term monitoring (refer to section 9.2) is used for monitoring (Fig 12:

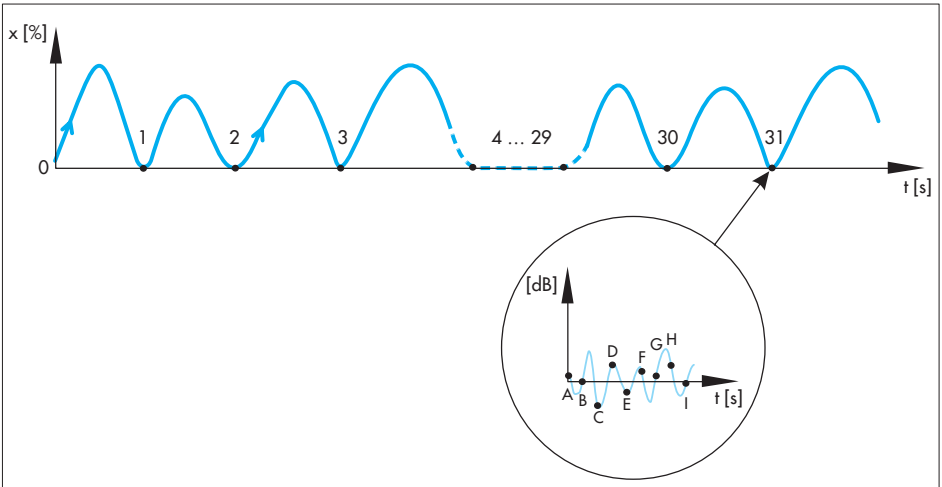


Fig. 12 · Tight-closing event and calculated mean values for process reference test assessment

Tight-closing event 2 to Tight-closing event 31 with all sound levels).

- **Very slow:** The mean value calculated all the sound levels measured during long-term monitoring (refer to section 9.3) is used for monitoring (Fig. 12: Tight-closing event 1 to Tight-closing event 31 with all sound levels).

No alarm triggering means the alarms are deactivated.

Setting the function

1. Configure alarms.
2. Assign status classification to status messages. Refer to section 9.1.2.3.

Start-up > Reference graphs > Leakage sensor > Process reference

1. – Response time: [No alarm triggering], Very quick, Quick, Slow, Very slow
– Preset alarm limits: [Manufacturer reference], Process reference, User-defined

Device settings > Alarm settings > Status classification > Valve

2. – Alarm limit 2 exceeded: [⊗], ◈, ⊗, ⚠
– Alarm limit 3 exceeded: [⊗], ◈, ⊗, ⚠

9.1.2.3 Monitoring

If the determined mean sound level exceeds the *Alarm limit 2*, the positioner generates the 'Seat leakage' message with status classification selected for *Alarm limit 2 exceeded*.

If the determined mean sound level exceeds the *Alarm limit 3*, the positioner generates the 'Seat leakage' message with status classification selected for *Alarm limit 3 exceeded*.

Diagnostics > Monitoring > Valve

– Seat leakage: ☑, ◈, ⊗, ⚠

9.1.2.4 Single reset

The process reference (diagnostic parameters, measured data and analysis) can be reset by selecting and executing the command *Reset 'Leakage sensor process reference'*.

If the test is restarted when the process reference already exists, the analysis of the existing process reference is overwritten.

Diagnostics > Service/maintenance > Reset

– Reset 'Leakage sensor process reference'

9.2 Short-term monitoring

Short-term monitoring provides an insight into short-term changes in the sound level while the valve is tightly shut.

Data are recorded automatically regardless of the operating mode. This function does not need to be activated by the user.

The leakage sensor records the sound level when the valve leaves tight shut position or whenever the sound level changes by 2 dB. A mean value is calculated from the recorded sound level and last four recorded sound levels. If this mean value deviates from the last mean value in short-term monitoring by the amount entered in *Sensitivity sound level*, it is saved as the new mean value in short-term monitoring.

The last *Mean value* recorded in short-term monitor is indicated.

The positioner saves the mean values of the sound level and travel in the FIFO memory with a memory depth of 30 values together with a time stamp. The saved values can be read in the **Measured data assessment** folder.

Setting the function

1. Set *Sensitivity sound level*.

Diagnostics > Monitoring/tests > Leakage sensor > Short-term monitoring

1. – Sensitivity sound level: 3 to 255 dB, [3 dB]

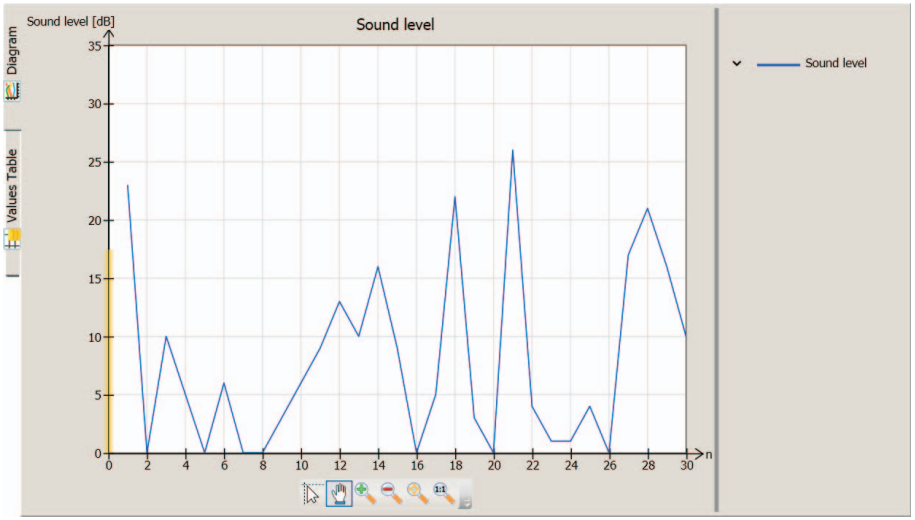


Fig. 13 · Diagnostics > Monitoring/tests > Leakage sensor > ***Short-term monitoring***

9.2.1 Single reset

The short-term monitoring (diagnostic parameters, measured data and analysis) can be reset by selecting and executing the command *Reset 'Short-term leakage sensor monitoring'*. This also resets the data in the **Measured data assessment** directory.

Diagnostics > Service/maintenance > Reset
– Reset 'Short-term leakage sensor monitoring'

9.3 Long-term monitoring

To obtain a sound level trend over a long period of time, the long-term monitoring contains all the mean values saved in the short-term monitoring since the last reset:

- Mean value: Mean sound level calculated from the Number of averages
- Number of averages

Data are recorded automatically regardless of the operating mode. This function does not need to be activated by the user.

9.3.1 Single reset

The measured data in the long-term monitoring can be reset by selecting and executing the command *Reset 'Long-term leakage sensor monitoring'*.

Diagnostics > Service/maintenance > Reset
– Reset 'Long-term leakage sensor monitoring'

9.4 Sound level (x)

The sound level monitoring is shown in a histogram. The distribution of recorded sound levels within fixed classes of *Valve position x* is revealed.

The leakage sensor records the sound level every second and assigns the data into predefined valve positions classes. The distribution of valve positions classes is shown in a bar graph.

Data are recorded automatically regardless of the operating mode. This function does not need to be activated by the user.

9.4.1 Single reset

The measured data in the long-term monitoring can be reset by selecting and executing the command *Reset 'Leakage sensor sound level (x)'*.

Diagnostics > Service/maintenance > Reset
– Reset 'Leakage sensor sound level (x)'

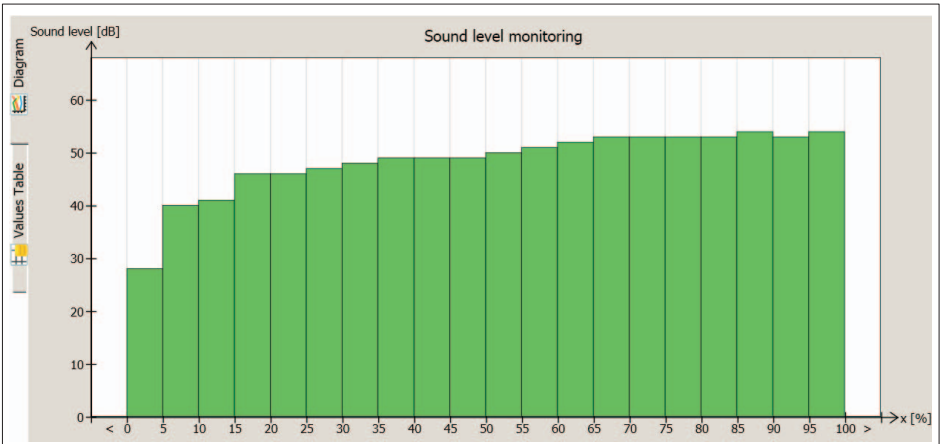
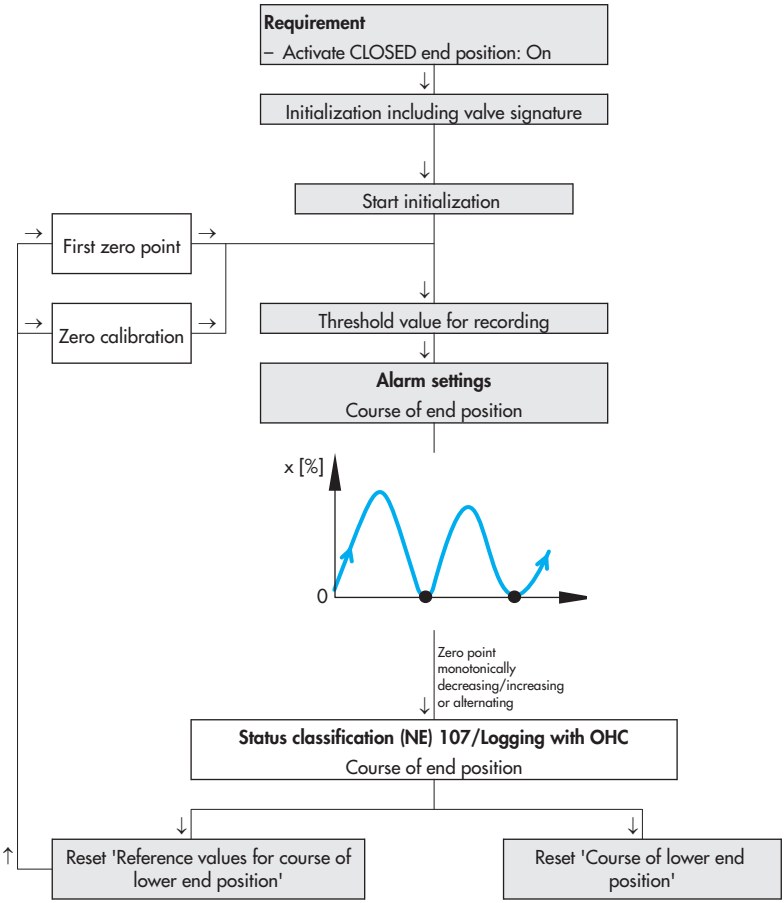


Fig. 14 · Diagnostics > Monitoring/tests > Leakage sensor > ***Sound level (x)***

START-UP

PROCESS



10 Course of end position

This *course of end position* function is used to detect an alternating zero point or a creeping zero point shift due to seat and plug wear or dirt between the seat and plug.

Data are recorded automatically regardless of the operating mode **if tight-closing function is active** (Code 14). The *Course of end position* function does not need to be activated by the user.

The course of end position records the *Valve position x* and *Signal pressure* p_{out} together with the time stamp by the operating hours counter when the valve moves to the lower end position. The new recorded valve position is compared to the last saved zero point. If it differs by the *Threshold value for recording* from the last value, the data of the new zero point are saved.

A graph of the recorded end positions is plotted over time.

The positioner saves the valve positions in the FIFO memory with a memory depth of 30 values. The recorded data are listed in the **Lower end position** folder.

Setting the function

1. Activate the tight-closing function.
2. Set *Threshold value for recording*.
3. Assign status classification to status messages.

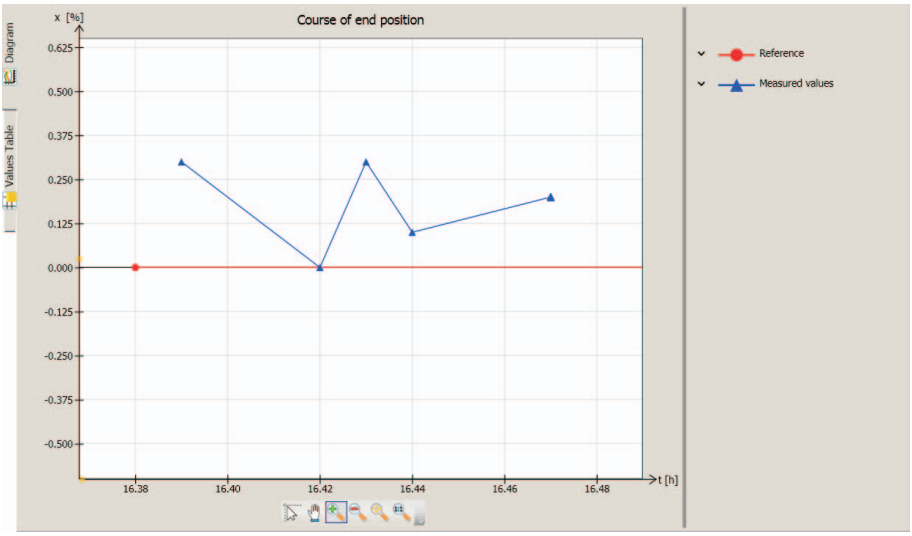


Fig. 15 · Diagnostics > Monitoring/tests > ***Course of end position***

Device settings > Positioner > Transfer characteristic or Transfer characteristic on/off

1. – Activate CLOSED end position (Code 14): **On**
   – CLOSED end position (Code 14): 0.0 to 49.9 %, [1.0 %]

Device settings > Alarm settings

2. – Threshold value for recording: 0.10 to 5.00 %, [0.25 %]

Device settings > Alarm settings > Status classification > Valve position

3. **Course of end position**
   – Monotonically increasing: [⊗], ◈, ⊗, ⚠
   – Monotonically decreasing: [⊗], ◈, ⊗, ⚠
   – Alternating: [⊗], ◈, ⊗, ⚠

10.1 Analysis and monitoring

A reference zero point is needed to analyze the course of the end position. This is recorded during the valve signature reference curve (refer to section 4.1). In case a reference graph has not been plotted, the first zero point that the valve moved to serves as the reference value.
The reference value is represented by a straight line in the *Course of end position* graph.

Note: *If the reference value has been reset by selecting and executing* Reset 'Reference values for course of lower end position' *(refer to section 2.1.1), the first zero point that the valve moves to after the reset serves as the new reference value, provided it does not exceed the* Zero point limit *(Code 48 - d5).*

If the analysis of the course of the end position detects a fault, the positioner generates the 'Course of end position' message with the defined status classification.

Diagnostics > Monitoring > Valve position

– Course of end position: ☑, ◈, ⊗, ⚠

10.2 Single reset

The 'Course of end position' message and the measured data for the course of the end position can be reset by selecting and executing *Reset 'Course of lower end position'*.

If only the reference zero point is to be reset, select and execute *Reset 'Reference values for course of lower end position'*.

Diagnostics > Service/maintenance > Reset

– Reset 'Course of lower end position'
– Reset 'Reference values for course of lower end position'

11 Valve dead band

The dead band is the difference in amount of the *Set point w* which causes a minimum change in *Valve position x*.

The valve dead band is affected by the friction hysteresis and the elastic processes in the valve stem packing.

This test is started when the positioner is in the manual operating mode.

The positioner specifies the *Set point w* in a defined test range (*Lower range value* and *Upper range value*) in small steps and records the response of the *Valve position x* after waiting a defined *Waiting time after step change*. The step height is determined automatically from the defined test range and the number of values (*No. until reversing)*. The ascendent and descendent are plotted within the test range. The response of the *Valve position x* to the change in set point (Δw) is plotted in a graph.

The dead band is analyzed in the positioner when a step height is smaller than 0.2 %:

- Mean dead band: Mean change in set point causing minimum valve stroking
- Min. dead band: Minimum change in set point causing minimum valve stroking
- Max. dead band: Maximum change in set point causing minimum valve stroking

Setting the function

1. Switch to manual operating mode (Code 0 = MAN).
2. Configure test.
3. Start test.
   The *Test information* reading indicates 'Test active'. *D3* and *TEST* are indicated

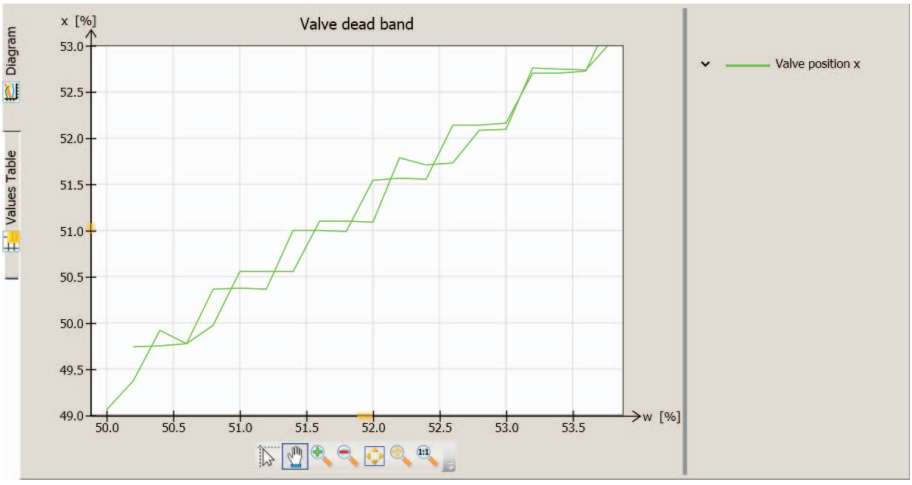


Fig. 16 · Diagnostics > Monitoring/tests > Dynamic tests > ***Valve dead band***

in alternating sequence on the positioner display.
'Function check' is activated as the condensed state.

Diagnostics > Service/maintenance > Operating mode

1. – Enter operating mode (Code 0): **Manual**

Diagnostics > Monitoring/tests > Dynamic tests > Valve dead band

2. – Lower range value: 0.0 to 100.0 %, [50.0 %]
– Upper range value: 0.0 to 100.0 % [52.0 %]
– Waiting time after step change: 0.1 to 25.0 s, [1.0 s]
– No. until reversing: 1 to [50]

3. – Start test

Note: *Cancel test by selecting and executing* Cancel test *or by pressing the rotary pushbutton.*
After the test is canceled, the positioner remains in the manual mode.

In TROVIS-VIEW 4 the test information and progress of the test are displayed. When the test has been successfully completed, the *Test information* reading indicates 'Test note active'.

11.1 Single reset

The diagnostic parameters and the measured data for the last test can be reset by selecting and executing *Reset 'Valve dead band'*.

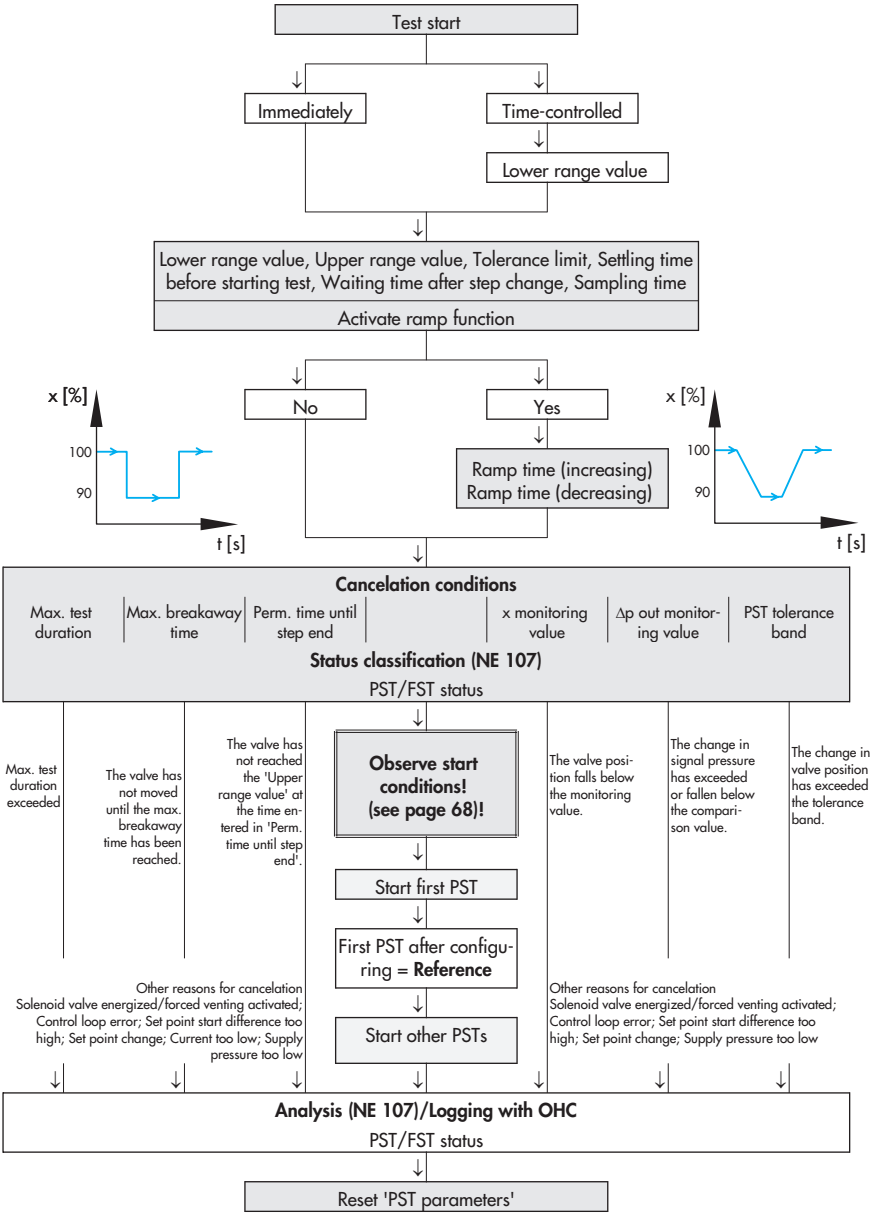
The old analysis is overwritten when the test is restarted when a test analysis already exists.

Diagnostics > Service/maintenance > Reset

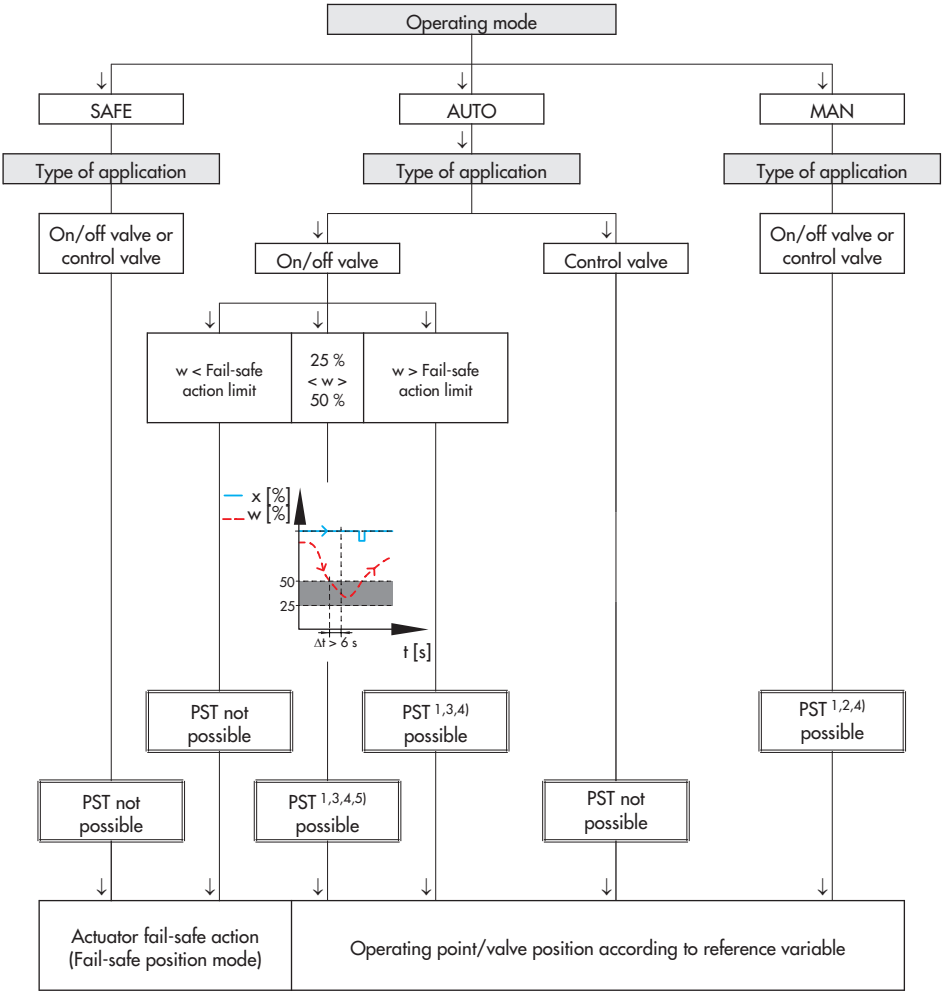
– Reset 'Valve dead band'

START-UP

TEST/PROCESS



Start conditions for PST



1) PST started once by operating software
2) PST started once using positioner's rotary pushbutton
3) PST started time-controlled
4) PST started by binary input
5) PST started once by Set point w, (section 5)

12 Partial stroke test (PST)

The partial stroke test (PST) is particularly suitable for the status-oriented detection of malfunctions in pneumatic shut-off valves. As a result, the probability of failure on demand (PFD) can be reduced and it may be possible to extend maintenance intervals. In this way, a valve normally in its end position can be prevented from seizing up or getting jammed.
Recording the test results additionally allows an analysis of the dynamic control response.

The partial stroke test can be performed once (test immediately started) or, with an on/off valve in automatic mode, regularly (time-controlled), provided the start conditions are met (see page 71):

- A control valve is in the manual operating mode.
- An on/off valve is in the manual or automatic mode. In automatic mode, the test is only started when the *Set point w* is greater than the *Fail-safe action limit* (Code 49 - h2).

The following listed parameters are activated while the partial stroke test is being performed:

- Select characteristic (Code 20): Linear
- Enter transit time OPEN (Code 21): variable
- Enter transit time CLOSED (Code 22): variable

During the partial stroke test, the valve moves from its current operating point to a defined Upper range value and back to the initial position again.

The change in travel can be performed either in steps or in a ramp function (Fig. 18). For the test in a ramp function, additionally

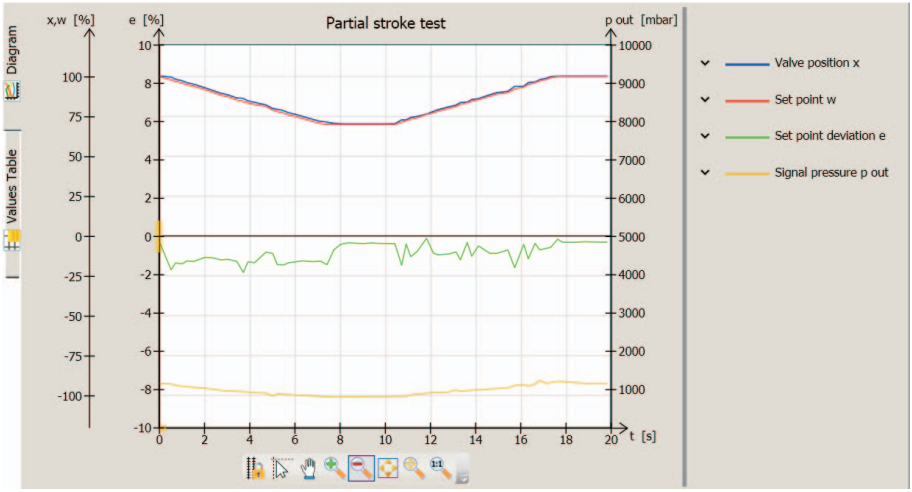


Fig. 17 · Diagnostics > Monitoring/test > Dynamic tests > ***Partial stroke test (PST)***

the velocities for the rising and falling ramps need to be defined.

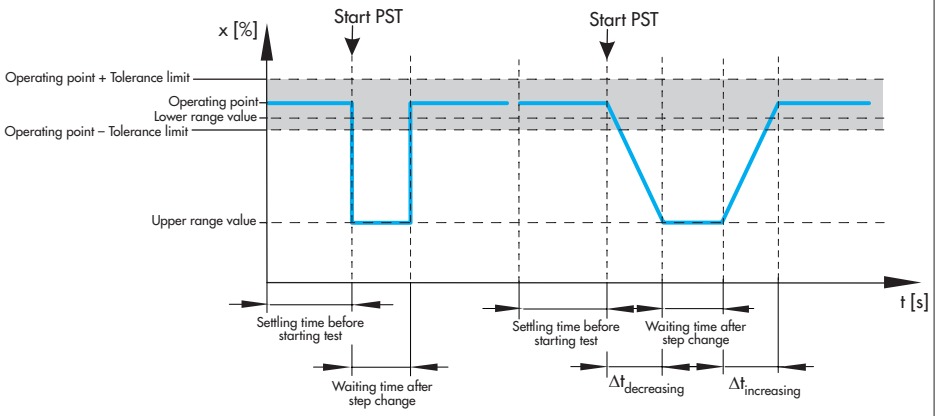
To perform the partial stroke test, the *Lower range value* parameter must be within the range of the current operating point ± *Tolerance limit*.

After being activated, the test does not start until the *Settling time before starting test* (t_1) has elapsed. Starting from the operating point (pos. 1), the valve moves to the *Upper range value* position (pos. 3). The valve remains in this position for the time defined by the *Waiting time after step change* (t_2) before performing a second step change in the opposite direction from the *Upper range value* position (pos. 3) towards the operating point (pos. 1).
The *Sampling time* determines the time interval at which the measured values are recorded during the test.

Cancelation conditions

Various cancelation conditions provide additional protection against the valve slamming shut or moving past the end position.
The positioner cancels the partial stroke test when one of the following activated cancelation conditions is fulfilled:
Time-out cancelation conditions

- Max. test duration: The test is canceled when the maximum test duration is reached.
- Max. breakaway time: The test is canceled when the valve has not moved within the adjusted time after *Settling time before starting test* has elapsed. This



$$\Delta t_{decreasing} = \frac{Lower\ range\ value - Upper\ range\ value}{100} * \text{'Ramp time (decreasing)'}$$

$$\Delta t_{increasing} = \frac{Lower\ range\ value - Upper\ range\ value}{100} * \text{'Ramp time (increasing)'}$$

Fig. 18 · Course of the partial stroke test: Change in travel performed in steps (left) and in ramp (right)

cancelation condition is only active when *Activate 'Max. breakaway time'* is set to Yes.

- Perm. time until step end: The test is canceled when the valve has not reached the *Upper range value* within the adjusted time after *Settling time before starting test* has elapsed. This cancelation condition is only active when *Activate 'Perm. time until step end'* is set to Yes.

Valve position x cancelation condition

- x monitoring value: The test is canceled as soon the valve position falls below the adjusted value.
  This cancelation condition is only active when *Activate x monitoring'* is set to Yes.

Signal pressure Δp_{out} cancelation condition

- Δp out monitoring value: The test is canceled when the change in signal pressure falls below or exceeds the reference value. The reference value is made up of the Δp out reference value and the Δp out monitoring value.
  This cancelation condition is only active when *Activate Δp out* monitoring is set to Yes.

  The positioner calculates the Δp out reference value from both signal pressures at the *Upper range value* and *Lower range value*. It only applies to the adjusted step and ramp values.

Tolerance band cancelation condition

- PST tolerance band: The test is canceled as soon the deviation of the valve position (in relation to the *Upper range value* of the step) exceeds the adjusted *PST tolerance band*.
  This cancelation condition is only active when *Activate PST tolerance band monitoring* is set to Yes.

Note:

– *The partial stroke test must be performed with deactivated cancelation conditions for valves with double-acting actuator and pneumatic booster as well as for valves that have been initialized using the SUB mode (substitute calibration).*
– *Excessive overshooting may occur in valves fitted with boosters. In this case, the cancelation conditions x monitoring value and PST tolerance band must be increased accordingly.*

The partial stroke test is also canceled when one of the following events occurs:

- Cancel internal solenoid valve/forced venting: The internal solenoid valve has been energized/the forced venting has been activated.
- Canceled by control loop error: A control loop error has occurred.
- Set point start difference too high: The *Lower range value* of the step is outside the operating point range ± *Tolerance limit*.
- Set point change: The test was started according to a schedule (time-controlled). Due to a set point change before the step was started, the *Lower range value* of the step is outside the operating point range ± *Tolerance limit*.
- Current too low
- Supply pressure too low
- Electric current change: The partial stroke test of a control valve is canceled when

the change in electric current ≥ *Tolerance band* (Code 19) arises.
The partial stroke test of an on/off valve is canceled when the valve moves from the operating position to the fail-safe position or from the fail-safe position to the operating position due to a change in electric current

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Note: *The 'Measured data memory full' reading (Failure) is generated when the* Sampling time *is too low. After recording 100 data points per variable, logging is stopped, but the test continues until it is completed.*

After the partial stroke test is canceled, the *Partial stroke test status* reading indicates 'Not successful'. In **[PST measured data assessment > Current test]** the reason for cancelation is marked by the 'Failure' message.

Setting the function

1. Define the start conditions.
   (The default settings partly depend on the closing position ATO/ATC.)
2. Configure the partial stroke test. Read the note on setting the PST diagnostic parameters on page 73.
3. Configure the cancelation conditions.
4. Assign status classification to status messages.
5. Start partial stroke test.
   The *Test information* reading indicates 'Test active'. *D4* and *TEST* are indicated in alternating sequence on the positioner display.
   'Function check' is activated as the condensed state.

Diagnostics > Monitoring/tests > Dynamic tests > Partial stroke test (PST)

1. – Test start (Code 49 - A2): [Immediately], Time-controlled

For time-controlled test:

– Enter test interval (Code 49 - A3): [1 h] to 2345 d

2. – Lower range value (Code 49 - d2): 0.0 to 100.0 %, [ATO: 100.0 %; ATC: 0.0 %]
– Upper range value (Code 49 - d3): 0.0 to 100.0 % [ATO: 90.0 %; ATC: 10 %]
– Tolerance limit: 0.1 to 10.0 %, [2.0 %]
– Activate ramp function (Code 49 - d4): [Yes], No
– Settling time before starting test (Code 49 - d7): [1] to 240 s
– Waiting time after step change (Code 49 - d8): 1.0 to 240.0 s, [2.0 s]
– Sampling time (Code 49 - d9): [0.2] to 250.0 s

Only for activated ramp function:

– Ramp time (decreasing) (Code 49 - d5): 0 to 9999 s, [45 s]
– Ramp time (increasing) (Code 49 - d6): 0 to 9999 s, [45 s]

3. – Max. test duration (Code 49 - E7): [30] to 25000 s
– Activate 'Max. breakaway time': [Yes], No
– Max. breakaway time: 0.0 to 25000 s, [30.0 s]
– Activate 'Perm. time until step end': [Yes], No
– Perm. time until step end: 0.0 to 25000 s, [30.0 s]

– Activate x monitoring (Code 49 - E0): [Yes], No
– x monitoring value (Code 49 - E1): –10.0 to 110.0 %, [ATO: 0.0 %; ATC: 85 %]
– Activate Δp out monitoring (Code 49 - A8): [Yes], No
– Δp out monitoring value (Code 49 - A9): 0.00 to 7.00 bar, [1.00 bar]
– Activate PST tolerance band monitoring (Code 49 - E5): Yes, [No]
– PST tolerance band (Code 49 - E6): 0.1 to 100.0 %, [5.0 %]

Device settings > Alarm settings > Status classification > PST/FST

– x cancelation: [⊗], ◆, ⊗, ⚠
– Δp out cancelation: [⊗], ◆, ⊗, ⚠
– Tolerance band exceeded: [⊗], ◆, ⊗, ⚠
– Max. test duration exceeded: [⊗], ◆, ⊗, ⚠
– Test canceled manually: [⊗], ◆, ⊗, ⚠
– Measured data memory full: [⊗], ◆, ⊗, ⚠
– Cancel internal solenoid valve/forced venting: [⊗], ◆, ⊗, ⚠
– Canceled by control loop error: [⊗], ◆, ⊗, ⚠
– Set point start difference too high: [⊗], ◆, ⊗, ⚠
– Set point change: [⊗], ◆, ⊗, ⚠
– Current too low: [⊗], ◆, ⊗, ⚠
– Max. breakaway time exceeded: [⊗], ◆, ⊗, ⚠
– Perm. time until step end exceeded: [⊗], ◆, ⊗, ⚠
– Canceled by supply pressure: [⊗], ◆, ⊗, ⚠

Diagnostics > Monitoring/tests > Dynamic tests > Partial stroke test (PST)

4. – Start test

Note: *By selecting and executing* Cancel test *or by pressing the rotary pushbutton, the test is canceled.*
After canceling the test, the positioner remains in the selected operating mode.
The Partial stroke test status *reading indicates 'Not successful'.*

In TROVIS-VIEW 4 the test information and progress of the test are displayed. When the test has been successfully completed, the *Test information* reading indicates 'Test not active'.

Note concerning setting the PST diagnostic parameters

- The *Ramp time (increasing)* must be greater than the corresponding value for *Min. transit time CLOSED* (Code 41) determined during initialization.
- The *Ramp time (decreasing)* must be greater than the corresponding value for *Min. transit time OPEN* (Code 40) determined during initialization.
- The Sampling time must not be lower than the indicated *Recommended min. sampling time*. The *Recommended min. sampling time* is calculated from the *Expected duration of test*.

12.1 Start triggered by on/off valve

The partial stroke test of on/off valves is triggered when the *Set point w* moves away from the operating point into the travel range between 25 and 50 % and remains there longer than six seconds. Refer to section 5 and the illustration on page 71.

The partial stroke test is only performed when the *Lower range value* is within the range of the defined position ±Tolerance limit.

The test and its cancelation are described in section 12, while the test assessment is described in section 12.2.1.

12.2 Start triggered by a binary input

If the positioner is fitted with the optional binary input, the partial stroke test can be started by the binary input when the conditions to start the partial stroke test are met:

- A control valve is in the manual mode.
- An on/off valve is in the manual or automatic mode. In automatic mode, the test is only started when the *Safety set point* is greater than the *Fail-safe action limit* (Code 49 - h2).

The test and its cancelation are described in section 12, while the test assessment is described in section 12.2.1.

It is important to make sure that the diagnostic parameter, *Lower range value* of the partial stroke test is within the range of the *Safety set point* ± *Tolerance limit.*

Setting the function

1. Set the *Binary input* option.
2. Configure the binary input.
3. Assign status classification to status message.

Device settings > Positioner > Options

1. – Positioner accessories identification: **Binary input**

Device settings > Positioner > Options > Binary input configuration

2. – Binary input configuration: [For floating contact (switch function)], For non-floating contact (0-24 V)
– Select function: **Start PST**
– Binary input control: Activate function: Switch open, [Activate function: Switch closed]
– Safety set point: 0.0 to 100.0 %, [50.0 %]

3. – Binary input classification: [⊗], ◆, ⊗, ⚠

Note: *Section 15 contains more details on the optional binary input.*

12.2.1 Analysis and monitoring

The analysis of the last three partial stroke tests are saved with a time stamp in the PST measured data assessment folder. The last partial stroke test performed is displayed in a graph in the Partial stroke test (PST) folder.

Test completed successfully

When a partial stroke test has been completed successfully, additionally the analyzed parameters are displayed separately for the increasing and decreasing characteristics.

Measured data assessment (step response test):

- Overshooting (relative to step height) [%]
- Dead time [s]
- T86 [s]
- Setting time [s]

Measured data assessment (ramp function):

- Overshooting (relative to step height) [%]

The results of the first partial stroke test are used as the reference.

Note: *Changes in the diagnostic parameters listed below affect the test. The results of the partial stroke test that follows is used as the new reference:*

- *Lower range value*
- *Upper range value*
- *Activate ramp function*
- *Ramp time (increasing)*
- *Ramp time (decreasing)*
- *Waiting time after step change*

Test not completed

If the test was not completed, the reason for cancelation is indicated in the corresponding reading by the 'Failure' message. The positioner generates a 'PST/FST status' message with the defined status classification.

Diagnostics > Monitoring

- PST/FST status (Code 84): , , , 

Note: *The 'No test available' message remains until a partial stroke is completed successfully.*

12.3 Single reset

The diagnostic parameters and the measured data for the partial stroke test can be reset by selecting and executing *Reset 'PST parameters'*.

The old analysis is overwritten when the test is restarted when a test analysis already exists

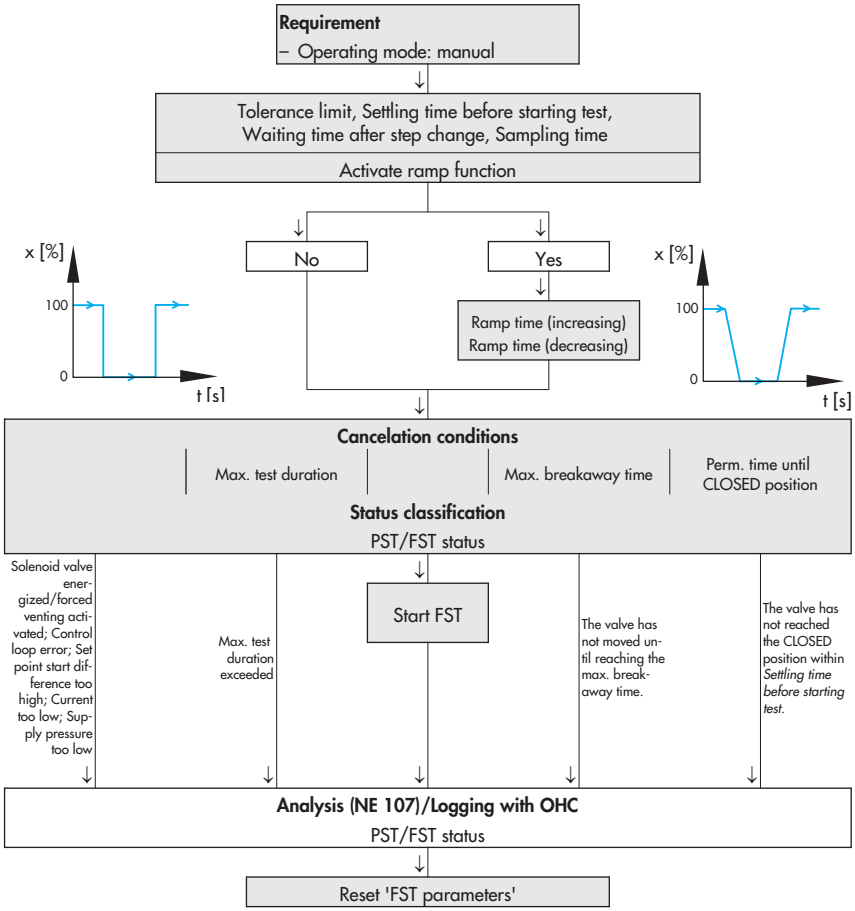
The positioner saves the measured data analysis of the last three partial stroke tests. The measured data analysis of the penultimate test is deleted when the next test is performed.

Diagnostics > Service/maintenance > Reset

- Reset 'PST parameters'

START-UP

TEST



13 Full stroke test (FST)

The dynamic valve performance can be evaluated by performing a full stroke test.

The full stroke test is started in the manual mode.

The following listed parameters are activated while the full stroke test is being performed:

- Select characteristic (Code 20): Linear
- Enter transit time OPEN (Code 21): variable
- Enter transit time CLOSED (Code 22): variable

During the full stroke test, the valve moves through its entire manipulated variable range.

The first step ends in the fail-safe position, meaning the second step starts from the fail-safe position.

The change in travel can be performed either in steps or in a ramp function (Fig. 20). For the test in a ramp function, additionally the velocities for the rising and falling ramps need to be defined.

The test does not start until the *Settling time before starting test* (t_1) has elapsed. This ensures that the valve has reached the start position.

Starting from the start position, the valve moves to the fail-safe position. The valve remains in this position for the time defined by the *Waiting time after step change (t_2)* before performing a second step change in the opposite direction from the fail-safe position to the start position of the first step.
After the Waiting time after step change (t_2)

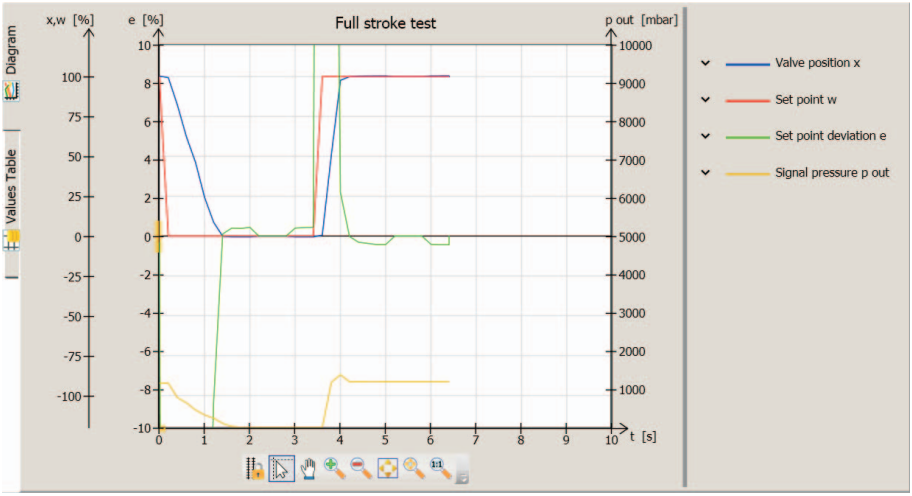


Fig.19 · Diagnostics > Monitoring/test > Dynamic tests > ***Full stroke test (FST)***

has elapsed the valve moves back to the operating position (position before the test started (reference variable, Pos. *).

The *Tolerance limit* parameter defines the permitted valve positions for the start value and end value for the step.

The *Sampling time* determines the time interval at which the measured values are recorded during the test.

Cancelation conditions

Various cancelation conditions provide additional protection against the valve slamming shut or moving past the end position.
The positioner cancels the full stroke test when one of the following activated cancelation conditions is fulfilled:

- Max. test duration: The test is canceled when the maximum test duration is reached.
- Max. breakaway time: The test is canceled when the valve has not moved within the adjusted time after *Settling time before starting test* has elapsed. This cancelation condition is only active when *Activate 'Max. breakaway time'* is set to Yes.
- Perm. time until CLOSED position: The test is canceled when the valve has not reached the CLOSED position within the adjusted time after *Settling time before starting test* has elapsed. This cancelation condition is only active when *Activate 'Perm. time until CLOSED position'* is set to Yes.

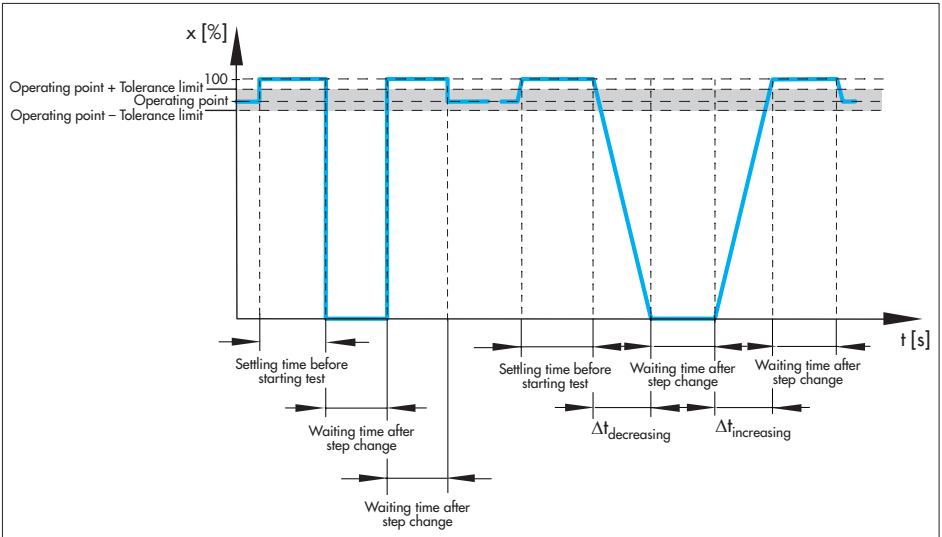


Fig. 20 · Course of full stroke test: Change in travel in steps (left) and as ramp function (right) Fail-close

Additionally, the full stroke test is canceled when one of the following events arises:

- Cancel internal solenoid valve/forced venting: The internal solenoid valve has been energized/the forced venting has been activated.
- Canceled by control loop error: A control loop error has occurred.
- Set point start difference too high: The Lower range value of the step is outside the operating point range ± *Tolerance limit*.
- Current too low
- Supply pressure too low

Note: *The 'Measured data memory full' reading (Failure) is generated when the* Sampling time *is too low. After recording 100 data points per variable, logging is stopped, but the test continues until it is completed.*

After the full stroke test is canceled, the *FST status* reading indicates 'Not successful'. In **[FST measured data assessment > Current test]** the reason for cancelation is marked by the Failure message.

Setting the function

1. Switch to manual mode (Code 0 = MAN).
2. Configure the full stroke test. Read the note on setting the FST diagnostic parameters on page 80.
3. Configure the cancelation conditions.
4. Assign status classification to status messages.
5. Start full stroke test.
   The *Test information* reading indicates 'Test active'. *D6* and *TEST* are indicated in alternating sequence on the positioner display.
   'Function check' is activated as the condensed state.

Diagnostics > Service/maintenance> Operating mode

– Enter operating mode (Code 0): **Manual**

Diagnostics > Monitoring/tests > Dynamic tests > Full stroke test (FST)

2. – Tolerance limit: 0.1 to 10.0 %, [2.0 %]
– Activate ramp function: [Yes], No
– Settling time before starting test: [1] to 240 s
– Waiting time after step change: [2.0] to 100.0
– Sampling time: [0.2] to 250.0 s

Only for activated ramp function:

– Ramp time (increasing): 0 to 9999 s, [1 s]
– Ramp time (decreasing): 0 to 9999 s, [1 s]

3. – Max. test duration: [30] to 25000 s
– Activate 'Max. breakaway time': Yes, [No]
– Max. breakaway time: 0.0 to 25000 s, [30.0 s]
– Activate 'Perm. time until CLOSED position': Yes, [No]
– Perm. time until CLOSED position: 0.0 to 25000 s, [30.0 s]

Device settings > Alarm settings > Status classification > PST/FST

– Max. test duration exceeded: [ ], , ,
– Test canceled manually: [ ], , ,

- Measured data memory full: [⊗], ◆, ⊗, ⚠
- Cancel internal solenoid valve/forced venting: [⊗], ◆, ⊗, ⚠
- Canceled by control loop error: [⊗], ◆, ⊗, ⚠
- Set point start difference too high: [⊗], ◆, ⊗, ⚠
- Set point change: [⊗], ◆, ⊗, ⚠
- Current too low: [⊗], ◆, ⊗, ⚠
- Max. breakaway time exceeded: [⊗], ◆, ⊗, ⚠
- Perm. time until CLOSED position exceeded: [⊗], ◆, ⊗, ⚠
- Canceled by supply pressure: [⊗], ◆, ⊗, ⚠

Diagnostics > Monitoring/tests > Dynamic tests > Full stroke test (FST)

4. – Start test

Note concerning setting the FST diagnostic parameters

- The *Ramp time (increasing)* must be greater than the corresponding value for *Min. transit time CLOSED* (Code 41) determined during initialization.
- The *Ramp time (decreasing)* must be greater than the corresponding value for *Min. transit time OPEN* (Code 40) determined during initialization.
- The Sampling time must not be lower than the indicated *Recommended min. sampling time*. The *Recommended min. sampling time* is calculated from the *Expected duration of test*.

13.1 Analysis and monitoring

The analysis of the last three partial stroke tests are saved with a time stamp in the FST measured data assessment.

Test completed successfully

When a full stroke test has been completed successfully, additionally the analyzed parameters are displayed separately for the increasing and decreasing characteristics.

Measured data assessment (step response test):

- Overshooting (relative to step height) [%]
- Dead time [s]
- T86 [s]
- Setting time [s]

Measured data assessment (ramp function):

- Overshooting (relative to step height) [%]

The results of the first full stroke test are used as the reference.

Note: *Changes in the diagnostic parameters listed below affect the test. The results of the full stroke test that follows is used as the new reference:*

- *Activate ramp function*
- *Ramp time (increasing)*
- *Ramp time (decreasing)*
- *Waiting time after step change*

Test not completed

If the test was not completed, the reason for cancelation is indicated in the corresponding reading by the 'Failure' message. The

positioner generates a 'PST/FST status' message with the defined status classification.

Diagnostics > Monitoring

– PST/FST status (Code 84): 

Note: *The 'No test available' message remains until a full stroke is completed successfully.*

13.2 Single reset

The diagnostic parameters of the full stroke test can be reset by selecting and executing *Reset 'FST parameters'*. The measured data analysis and the 'PST/FST status' message cannot be reset.

The positioner saves the measured data analysis of the last three full stroke tests. The measured data analysis of the penultimate test is deleted when the next test is performed.

Diagnostics > Service/maintenance > Reset

– Reset 'FST parameters'

14 SIL operator test

The SIL operator ensures that the safety function of the positioner is working. The safety function is based on the shutdown of the i/p converter (6, Fig. 22). This causes the pneumatic actuator to be vented and the valve to move to its fail-safe position.

Monitoring of the input signal

The i/p converter is switched off when the input signal of the positioner at terminals +11/–12 falls below 3.8 mA (a signal range of 4 to 20 mA is required). See Fig. 21.

Monitoring the voltage supply
(version with forced venting and solenoid valve)

The i/p converter and the solenoid valve (when installed) are shut down whenever the voltage at terminals +81/–82 falls below 12 V (an input voltage of 24 V DC is required). See Fig. 21.

The SIL operator test checks the emergency shutdown by the integrated safety function (SIL). It can be started in the manual or automatic mode of control valves.

The positioner generates a permanent message in the event that an error occurs during the operator test. All control properties of the positioner remain kept. Only the emergency shutdown function of the positioner is no longer guaranteed.

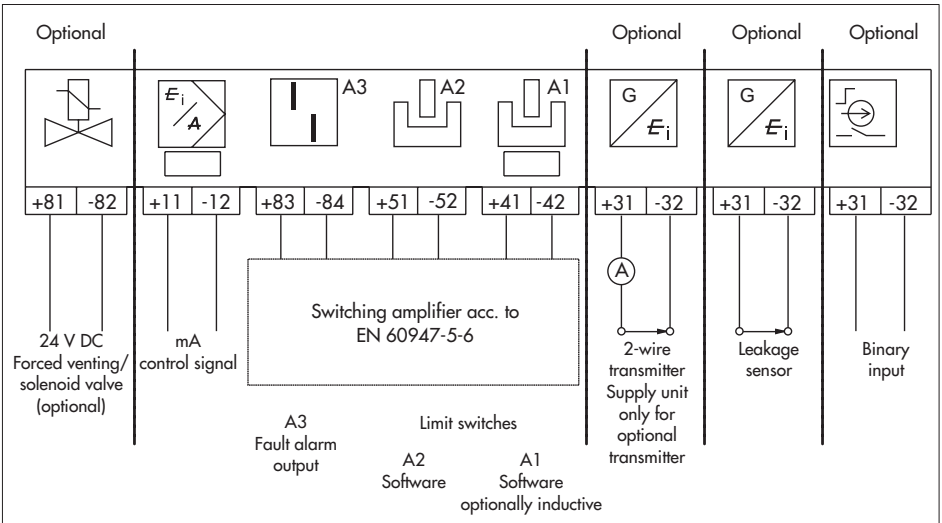
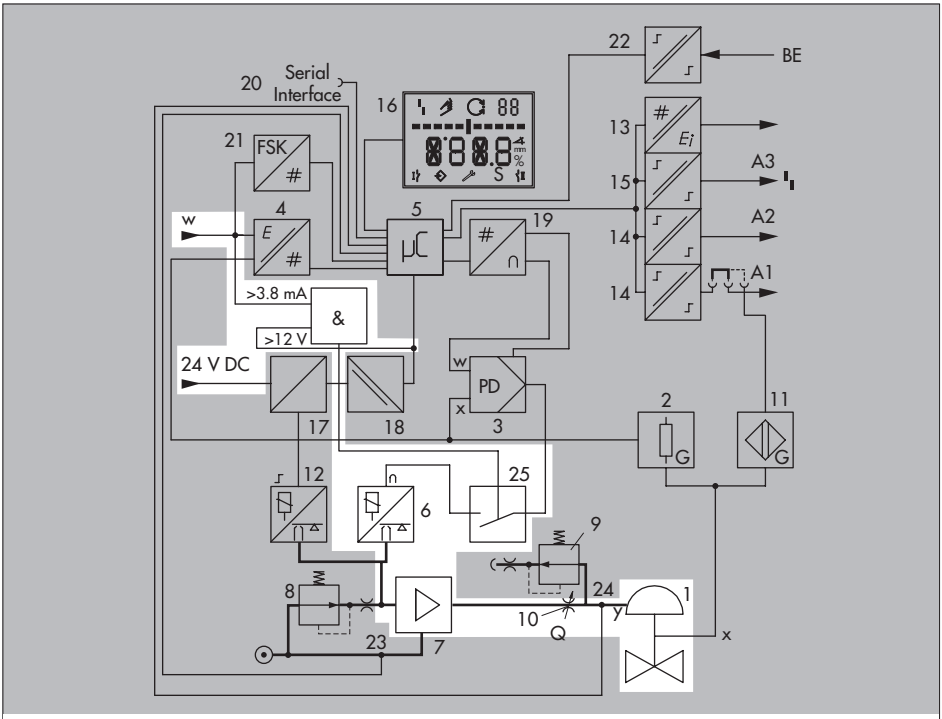


Fig. 21 · Electrical connections



1 Control valve
2 Travel sensor
3 PD controller
4 A/D converter
5 Microcontroller
6 i/p converter
7 Pneumatic booster
8 Pressure regulator
9 Flow regulator
10 Volume restriction
11* Inductive limit switch
12* Solenoid valve
13* Analog position transmitter or binary input
14 Software limit switches A1/A2
15 Fault alarm output A3
16 LCD
17* Control of solenoid valve
18* Galvanic isolation
19 D/A converter
20 Communication interface
21 HART® connection
22 Binary input BE*
23 Pressure sensor for supply air p_s
24 Pressure sensor for signal pressure p_{out}
25* Forced venting
* Option

Fig. 22 · Functional diagram

NOTICE
The SIL operator test causes the valve to move automatically. It must only be started when the plant allows it.

Setting the function

1. Set *Type of application* to *Control valve*.
2. Apply an external set point from 4.0 to 4.5 mA.
3. Start SIL operator test.
   S001 to *S030* appear on the positioner display one after the other.

Start-up

1. – Type of application (Code 49 - h0): **Control valve**

Diagnostics > Service/maintenance > SIL operator test

3. – Start SIL operator test

Diagnostics > Service/maintenance> SIL operator test

– SIL test: ☑ , ⊗

14.1 Analysis and monitoring

SIL operator test completed successfully

OK appears on the positioner display.

SIL operator test not completed

Possible error code E001 to E030 appears on the positioner display. The positioner generates the permanent error code 86 (Failure - this status classification cannot be changed).

The emergency shutdown function of the positioner is no longer guaranteed.
The positioner should be immediately returned to SAMSON.

15 Binary input

Type 3730-6xxxxx3x00x0x00

The positioner has an optional binary input to activate various functions:

- [Transmit switching state]
  The switching state of the binary input is logged.
- Activate local write protection
  After the first initialization, a local write protection can be activated. While the binary input is active, no settings ca be changed at the positioner. The positioner cannot be re-initialized. Configuration enabling over **Code 3** is not active.
- Start PST
  The positioner start a single partial stroke test. The test is performed with the settings in **Code 49 - d2** to **Code 49 - d9**. Refer to section 12.
- Move valve to safety set point
  An on/off valve moves to the predetermined *Safety set point* when the positioner is in automatic mode. This function is not performed if the positioner is in the manual mode or fail-safe position mode.
- Switch AUTO/HAND
  The positioner changes from the automatic mode to the manual mode or vice versa.
  This function is not performed if the positioner is in the fail-safe position mode.
- Start data logger
  Activation of the binary input causes the data logger to start. Refer to section 3.
- Reset diagnostics
  Active monitoring is stopped and the diagnostic data is reset once.

Note: *The optional binary input can only be configured using TROVIS-VIEW 4 software and using the DD parameters. In the default setting, the switch state is logged with a closed switch.*

Setting the function

Note:
- *The binary input can only be configured in TROVIS-VIEW 4 after* Positioner accessories identification *is set to* Binary input.
- *The* Safety set point *can only be set when the* Type of application *is set to* On/off valve.

1. Enter the binary input option.
2. Configure binary input.

Device settings > Positioner > Options

1. – Positioner accessories identification: **Binary input**

Device settings > Positioner > Options > Binary input configuration

2. – Binary input configuration: [For floating contact (switch function)], For non-floating contact (0-24 V)

- Select function: [Transmit switching state], Activate local write protection, Start PST, Move valve to safety set point, Switch AUTO/HAND, Start data logger, Reset diagnostics
- Binary input control: Activate function: Switch open, [Activate function: Switch closed]
- Safety set point: 0.0 to 100.0 %, [50.0 %] **(only when Type of application = On/off valve)**
- Binary input classification: [],  ,  , 

16 Flow rate calculation

Due to the differential pressure measurement Δp out, EXPERTplus is able to calculate the flow rate in a **SAMSON Type 3241 or Type 3251 Valve,** provided all the parameters regarding the medium and the process have been defined in the positioner.

Additional conditions include:

Valve

- Valve designation: Type 3241 or Type 3251
- Plug type: parabolic or V-port
- Noise reduction: none
- Type of packing: Standard (PTFE + PTFE/carbon, live-loaded), Form A (PTFE/carbon and PTFE/silk cord), Form C (PTFE-silk cord), Form B (pure PTFE and PTFE-silk cord) or PTFE (glass-fiber reinforced)
- Facing: metal-to-metal or lapped-in
- Pressure balancing: without
- Direction of flow: flow-to-open or flow-to-close
- Valve characteristic: linear or equal percentage

Note: *Additionally, the valve coefficient K_{VS} must be ≥ 1. This condition is not prompted by the positioner.*

Type 3271 or Type 3277 Actuator

- Detected spring range ≥ 0.8 bar
- Detected lower spring range value ≥ 0.4 bar

Initialization

- Initialization mode: nominal range (NOM)

Setting the function

1. Enter the process data.
2. Check the start conditions for the flow rate calculation.
3. Start flow rate calculation.

Device settings > Process data

1.
- State of process medium: [-/-], Liquid
- Constant pressure level at: [-/-], Input pressure p1, Output pressure p2
- Input pressure p1: [0.0] to 500.0 bar(a), only when Constant pressure level at = Input pressure p1
- Output pressure p2: [0.0] to 500.0 bar(a), only when Constant pressure level at = Output pressure p2 or -/-.
- Inlet density: 0.000 to 2000.000 kg/m³

2. Device settings > Process data > Start conditions for flow rate calculation

- Type designation = '3241' or '3251' = **Yes**
- Plug type = 'V-port' or 'Parabolic' = **Yes**
- Noise reduction = 'None' = **Yes**
- Packing types = 'Standard, 'Form A', 'Form C', 'Form B', or 'PTFE (glass-fiber reinforced)' = **Yes**
- Facing= 'Metal-to-metal ' or 'Lapped-in' = **Yes**
- Pressure balancing = 'Without' = **Yes**
- Flow direction= 'FTO (flow-to-open)' or 'FTC (flow-to-close)' = **Yes**
- Seat diameter entered = **Yes**
- Valve characteristic = 'Linear' or 'Equal percentage' = **Yes**

- Effective actuator area entered = **Yes**
- Detected spring range ≥ 0.8 bar = **Yes**
- Detected lower spring range value ≥ 0.4 bar = **Yes**
- Inlet density entered = **Yes**
- Inlet pressure p1 entered = **Yes**
- Initialization mode = 'Nominal range (NOM)' = **Yes**

3. Device settings > Process data

- Start flow rate calculation

Note:

- *To achieve high accuracy of the flow rate calculation even at high pressure drops, the inlet pressure p1 and outlet pressure p2 must be entered.*
- *The flow rate calculation only starts when the inlet pressure p1 or outlet pressure p2 and the inlet density are not set to 0.*

The momentary flow rate can be read in the **Measured process values** folder and can be forwarded to the process control system using a dynamic HART® variable.

17 Appendix

17.1 Error messages and recommended corrective action

Message	Possible cause	Recommended corrective action	Status classification	Single reset
[Diagnostics > Monitoring > Positioner]				
Control loop (Code 57)	– Actuator blocked – Positioner attachment shifted after mounting. – Insufficient supply pressure	– Check attachment – Check supply pressure	• []	–
Zero point (Code 58)	– Mounting position or linkage of positioner slipped – Valve trim, especially when soft-seated plug is used, worn	– Check valve and positioner attachment – Perform zero calibration We recommend re-initializing the positioner if the zero points deviates by more than 5 %.	• []	•
Inconsistent data memory (Code 59)	The error is detected by automatic monitoring and automatically corrected.		–	•
Internal device error (Code 60)	– Electromagnetic interference	– Reset initialization – Re-initialize the positioner	–	•
Kp too low (Code 61)	A proportional-action coefficient Kp level lower than 3 was detected during initialization.	– Activate the volume restriction in the positioner outlet	• []	•
x signal (Code 62)	– Measured data logging for actuator failed – Conductive plastic element defective	Return the positioner to SAMSON for repair.	–	–
w too low (Code 63)	– Set point (w) lower than 3.7 mA. This state is indicated on the positioner display by ***LOW*** blinking.	– Check set point (w). If necessary, restrict lower limit of current source to ensure that a current below 3.7mA cannot be issued.	• []	–
i/p converter (Code 64)	The electric current circuit of the i/p converter is interrupted	Return the positioner to SAMSON for repair.	–	–
Hardware (Code 65)		Confirm error and select automatic operating mode. If not successful, reset initialization and re-initialize the positioner.	–	•

Message	Possible cause	Recommended corrective action	Status classification	Single reset
Check calculation (Code 67)		Confirm error. If not possible, return the positioner to SAMSON for repair.	–	•
Pressure sensor (Code 72)	Pressure sensor(s) for supply air and/or signal pressure defective	Return the positioner to SAMSON for repair.	–	–
Collective error (Code 79)	Messages generated in EXPERTplus	–	–	–
SIL test (Code 86)	SIL operator test failed	Return the positioner to SAMSON for repair.	–	–
Set point outside range	Set point lower than 4 mA or higher than 20 mA.	If necessary, restrict lower limit (4 mA) and/or upper limit (20 mA) of current source.	–	–
Binary input status	Binary input is active		–	–
Temperature status	– Temperature fallen below –40 °C – Temperature exceeded +80 °C		• []	–
x > range (Code 50)	– Pin not mounted correctly – NAMUR attachment: bracket slipped or follower pin not properly seated in the slot of the follower plate – Follower plate not mounted correctly	– Check attachment and pin position – Re-initialize the positioner	• []	•
Δx < range (Code 51)	– Pin not mounted correctly – Wrong lever mounted – Pressure limit set too low	– Check attachment and pressure limit – Re-initialize the positioner	• []	•
Attachment (Code 52)	– Wrong lever mounted – Supply pressure too low. The valve cannot move to the required position. – During initialization with Nominal range (NOM) initialization mode, the nominal range could not be achieved.	– Check attachment and supply pressure – Re-initialize the positioner	• []	•

Message	Possible cause	Recommended corrective action	Status classification	Single reset
Initialization time exceeded (Code 53)	Timeout detected during initialization – Valve takes too long to open – Valve cannot find fixed end stops (e.g. when lined control butterfly valves are used) – Valve tends to hunt considerably.	– Check supply pressure and install pneumatic volume booster, if necessary. – Adjust end stops. – Reduce hunting tendency (e.g. restrict or open booster bypass). Then re-initialize the positioner.	• []	•
Internal solenoid valve/forced venting/supply pressure (Code 54)	Internal solenoid valve/forced venting not connected or incorrectly connected	– Check connection and supply voltage of the solenoid valve/forced venting. – Re-initialize the positioner.	• []	•
	An attempt was made to initialize the positioner while it is in the fail-safe position.	– Switch to manual mode. – Re-initialize the positioner.		
Transit time not reached (Code 55)	The transmit times of the actuator detected during initialization are too short (< 0.3 s), meaning optimal positioner tuning is not possible	– Activate the volume restriction in the positioner outlet. – Re-initialize the positioner.	• []	•
Pin/switch position (Code 56)	The pin position was not entered for NOM or SUB initialization mode.	– Enter pin position and nominal range. – Re-initialize the positioner	• []	•
	The ATO/ATC switch is defective	Return the positioner to SAMSON for repair.		
No emergency mode (Code 76)	The positioner detected during initialization that the actuator does not permit an emergency mode without feedback. When an error occurs in the travel measurement, the positioner vents the output or A1 when double-acting actuators are used.	Information only. No further action needs to be taken.	• []	–
Valve signature canceled (Code 81)	Error occurred during the recording of the valve signature. Refer to section 4.	Restart the valve signature recording or start initialization including valve signature.	• []	–

Message	Possible cause	Recommended corrective action	Status classification	Single reset
[Diagnostics > Monitoring > Valve]				
Friction change	– Friction is higher/lower in total range – Friction is higher/lower in mid-position – Friction is higher/lower near max. OPEN position – Friction is higher/lower near CLOSED position	Check packing.	• [⊗]	•
Seat leakage	– Either alarm limit 2 or 3 is exceeded	Check seat and plug.	• [⊗]	• Refer to section 9.1.2.4
	– Seat leakage may exist			• Refer to section 7.2
Packing leakage	Packing leakage possibly to be expected soon	Check packing.	• [⊗]	• Refer to section 8.2
Total valve travel exceeded	The *Absolute total valve travel* has exceeded the *Total valve travel limit.*		• [◆]	–
[Diagnostics > Monitoring > Actuator]				
Pneumatic leakage	A leakage in the pneumatic system exists.	Check that the pneumatic installations and connections are tight.	• [⊗]	–
Actuator springs defect	The pre-loading of the actuator springs reduced	Check springs in actuator.	• [⊗]	• Refer to section 4.5
Supply pressure status	– The supply pressure is outside the permissible limits.	Check supply pressure .	• [?]	• Refer to section 4.5
	– The supply pressure is too high.		• [◆]	
	– The supply pressure fluctuates.		• [⊗]	
	– The supply pressure is too low.		• [◆]	
	– No supply pressure available		• [?]	

Message	Possible cause	Recommended corrective action	Status classification	Single reset
[Diagnostics > Monitoring > Valve position]				
Manipulated variable range limitation	– The manipulated variable range is limited at the upper/lower range value. – The valve is jammed.	– Check pneumatic installations and connections to ensure they are tight. – Check supply pressure. – Check plug stem for mechanical blockage.	• [⊗]	• Refer to section 7.2
Course of end position	– The course of the end position is monotonically increasing/decreasing – The course of the end position alternates.	Check seat and plug.	• [⊗]	• Refer to section 10.2
Positioner-valve linkage	– No optimal travel transmission – The manipulated variable range is restricted.	Check attachment.	• [⊗]	• Refer to section 7.2
Manipulated variable range	– The manipulated variable range is mainly near the CLOSED position/max. OPEN position. – The manipulated variable range is mainly in the CLOSED position/max. OPEN position.	Rethink the operating range.	• [⊗]	• Refer to section 6.2
Course of manipulated variable range	– The operating range has shifted towards CLOSED position/max. OPEN position. – Short-term change of the manipulated variable range	Rethink the operating range.	• [⊗]	• Refer to section 6.2
[Diagnostics > Monitoring]				
PST/FST status (Code 84)	The partial stroke test or full stroke test was not completed successfully.	Read out test status. Refer to section 12/13.	• [⊗]	–

Message	Possible cause	Recommended corrective action	Status classification	Single reset
On/off valve (Code 85)	– The breakaway time or transit time differs from reference value by the amount entered in *Travel time assessment limit.* – The valve end position differs from reference value by the amount entered in *Valve end position limit.* – The valve end position is not reached.	Check valve and actuator.	• [⊗]	• Refer to section 5.3

17.2 Diagnostic data points saved in a non-volatile memory

	Data saved in a non-volatile memory	
	Saved directly after they change	Saved cyclically every 24 h
Monitoring	– Status classification – Alarm settings – Logging	
Data logger	Diagnostic parameters	
Valve signature	– Diagnostic parameters – Manufacturer reference – Process reference	Measured data – Long-term monitoring – Sound level (x)
On/off valve	Reference analysis	Analysis
Valve position histogram	Diagnostic parameters	Measured data in histogram
Set point deviation histogram	Diagnostic parameters	Measured data in histogram
Cycle counter histogram		Measured data in histogram
Lower end position	Measured data	
Valve dead band		
Partial stroke test (d4)	– Diagnostic parameters – Test cancelation conditions – Δp out reference value – Step response – Measured data analysis – Number of tests	
Full stroke test (d6)	– Diagnostic parameters – Test cancelation conditions – Δp_out reference value – Step response – Measured data analysis – Number of tests	

17.3 Parameter reset

Parameter	Reset Code 36		
	Diag	Std	DS
[Start-up]			
Type of application (Code 49 - h0)	NO	YES	YES
Reading direction (Code 2)	NO	YES	YES
Initialization mode (Code 6)	NO	YES	YES
Initialization including valve signature (Code 48 - h0)	NO	YES	YES
Pin position (Code 4)	NO	YES	YES
Enter nominal range	NO	YES	YES
Pressure limit (Code 16)	NO	YES	YES
Actuator motion	NO	NO	YES
Principle of operation (Code 48 - d11)	NO	NO	YES
Stem seal	NO	NO*	YES
* *Max. cycle limit* set to 1000000			
[Start-up > Fail-safe action]			
Air supply failure	NO	NO	YES
Power supply failure of positioner	NO	NO	YES
Power supply failure of external solenoid valve	NO	NO	YES
Emergency mode	NO	NO	NO
[Start-up > Control parameters]			
Proportional-action coefficient Kp level (Code 17)	NO	NO	NO
Derivative-action time Tv level (Code 18)	NO	NO	NO
[Start-up > Substitute calibration]			
Initialization mode (Code 6)	NO	YES	YES
Activate upper travel/angle limit (Code 11)	NO	YES	YES
Direction of action (Code 7)	NO	YES	YES
Proportional-action coefficient Kp level (Code 17)	NO	NO	NO
Derivative-action time Tv level (Code 18)	NO	NO	NO
Substitute calibration optimization	NO	YES	YES
[Initialization > Reference graphs > Valve signature]			
Sensitivity	YES	YES	YES

Parameter	Reset Code 36		
	Diag	Std	DS
[Initialization > Reference graphs > Leakage sensor > Manufacturer reference]			
Settling time before sound level measurement	NO	NO	NO
Sensitivity sound level	NO	NO	YES
Set points	NO	NO	YES
[Initialization > Reference graphs > Leakage sensor > Process reference]			
Settling time before sound level measurement	NO	NO	NO
Sensitivity sound level	NO	NO	YES
Response time	NO	NO	YES
Preset alarm limits	NO	NO	YES
Alarm limit 1 to 3	NO	NO	YES
Set points	NO	NO	YES
[Device settings > Positioners]			
Attachment	NO	NO	YES
Inductive limit switch (Code 38)	NO	NO	NO
[Device settings > Positioners > Transfer characteristic]			
Direction of action (Code 7)	NO	YES	YES
Set point, lower range value (Code 12)	NO	YES	YES
Set point, upper range value (Code 13)	NO	YES	YES
Activate CLOSED end position (Code 14)	NO	YES	YES
CLOSED end position (Code 14)	NO	YES	YES
Activate OPEN end position (Code 15)	NO	YES	YES
OPEN end position (Code 15)	NO	YES	YES
Enter transit time OPEN (Code 21)	NO	YES	YES
Enter transit time CLOSED (Code 22)	NO	YES	YES
Lower travel/angle range value (Code 8)	NO	YES	YES
Upper travel/angle range value (Code 9)	NO	YES	YES
Activate lower travel/angle range limit (Code 10)	NO	YES	YES
Lower travel/angle range limit (Code 10)	NO	YES	YES
Activate upper travel/angle range limit (Code 11)	NO	YES	YES
Upper travel/angle range limit (Code 11)	NO	YES	YES
Select characteristic (Code 20)	NO	YES	YES
User-defined characteristic	NO	YES	YES

Parameter	Reset Code 36		
	Diag	Std	DS
[Device settings > Positioners > Transfer characteristic on/off]			
Activate CLOSED end position (Code 14)	NO	The *Type of application* is reset to *Control valve*. The Transfer characteristic on/off folder is not shown after the reset. The parameters of the Transfer characteristic on/off folder are reset to their default settings.	
CLOSED end position (Code 14)	NO		
Activate OPEN end position (Code 15)	NO		
OPEN end position (Code 15)	NO		
Enter transit time OPEN (Code 21)	NO		
Enter transit time CLOSED (Code 22)	NO		
Operating point (Code 49 - h1)	NO		
Fail-safe action limit (Code 49 - h2)	NO		
Operating point limit (Code 49 - h5)	NO		
[Device settings > Positioners > HART® communication]			
Bus address (Code 46)	NO	NO	YES
Enter no. of preambles	NO	NO	YES
Primary variable assignment	NO	NO	YES
Secondary variable assignment	NO	NO	YES
Tertiary variable assignment	NO	NO	YES
Quartenary variable assignment	NO	NO	YES
HART® write protection	NO	NO	YES
[Device settings > Valve]			
Valve manufacturer	NO	NO	YES
Actuator motion	NO	NO	YES
Valve design	NO	NO	YES
Type designation	NO	NO	YES
Valve serial no.	NO	NO	YES
Configuration ID	NO	NO	YES
Valve standard	NO	NO	YES
Valve size DN	NO	NO	YES
Flow direction	NO	NO	YES
Stem seal	NO	NO	YES
Packing type	NO	NO	YES
Friction coefficient of packing	NO	NO	YES
Pressure balancing	NO	NO	YES

Parameter	Reset Code 36		
	Diag	Std	DS
Facing (leakage class)	NO	NO	YES
Friction coefficient of facing	NO	NO	YES
Bellows seal	NO	NO	YES
Seat diameter	NO	NO	YES
Kvs	NO	NO	YES
Kvs unit	NO	NO	YES
Plug type	NO	NO	YES
Valve characteristic	NO	NO	YES
Noise reduction	NO	NO	YES
[Device settings > Actuator]			
Actuator manufacturer	NO	NO	YES
Actuator motion	NO	NO	YES
Actuator type	NO	NO	YES
Type designation	NO	NO	YES
Principle of operation (Code 48 - d11)	NO	NO	YES
Configuration ID	NO	NO	YES
Actuator serial no.	NO	NO	YES
Effective actuator area	NO	NO	YES
Lower signal pressure range value	NO	NO	YES
Upper signal pressure range value	NO	NO	YES
Actuator fail-safe action	NO	NO	YES
Min. process pressure	NO	NO	YES
Max. process pressure	NO	NO	YES
Supply pressure	NO	NO	YES
Supply medium	NO	NO	YES
[Device settings > Further accessories]			
Filter regulator	NO	NO	YES
Reversing amplifier	NO	NO	YES
Booster	NO	NO	YES
Quick exhaust valve	NO	NO	YES
3/2-way valve	NO	NO	YES
Choke valve	NO	NO	YES

Parameter	Reset Code 36		
	Diag	Std	DS
Lock-up valve	NO	NO	YES
Limit switch	NO	NO	YES
External solenoid valve	NO	NO	YES
[Device settings > Process data]			
State of process medium	NO	NO	YES
Constant pressure level at	NO	NO	YES
Input pressure p1	NO	NO	NO
Output pressure p2	NO	NO	NO
Inlet temperature	NO	NO	NO
Inlet density	NO	NO	NO
Isentropic exponent	NO	NO	YES
[Device settings > Process data > Min. operating pressure]			
Input pressure p1	NO	NO	YES
Flow rate	NO	NO	YES
Output pressure p2	NO	NO	YES
Inlet temperature	NO	NO	YES
Inlet density	NO	NO	YES
Vapor pressure	NO	NO	YES
Critical pressure	NO	NO	YES
Isentropic exponent	NO	NO	YES
Compressibility factor	NO	NO	YES
Viscosity	NO	NO	YES
Flow coefficient	NO	NO	YES
Outlet velocity	NO	NO	YES
Relative travel/angle	NO	NO	YES
Difference pressure ratio	NO	NO	YES
Sound pressure level	NO	NO	YES
[Device settings > Process data > Normal operating point]			
Input pressure p1	NO	NO	NO
Flow rate	NO	NO	YES
Output pressure p2	NO	NO	NO
Inlet temperature	NO	NO	NO

Parameter	Reset Code 36		
	Diag	Std	DS
Inlet density	NO	NO	NO
Vapor pressure	NO	NO	YES
Critical pressure	NO	NO	YES
Isentropic exponent	NO	NO	YES
Compressibility factor	NO	NO	YES
Viscosity	NO	NO	YES
Flow coefficient	NO	NO	YES
Outlet velocity	NO	NO	YES
Relative travel/angle	NO	NO	YES
Difference pressure ratio	NO	NO	YES
Sound pressure level	NO	NO	YES
[Device settings > Process data > Max. operating point]			
Input pressure p1	NO	NO	YES
Flow rate	NO	NO	YES
Output pressure p2	NO	NO	YES
Inlet temperature	NO	NO	YES
Inlet density	NO	NO	YES
Vapor pressure	NO	NO	YES
Critical pressure	NO	NO	YES
Isentropic exponent	NO	NO	YES
Compressibility factor	NO	NO	YES
Viscosity	NO	NO	YES
Outlet velocity	NO	NO	YES
Flow coefficient	NO	NO	YES
Relative travel/angle	NO	NO	YES
Difference pressure ratio	NO	NO	YES
Sound pressure level	NO	NO	YES
[Device settings > Alarm setting]			
Tolerance band (Code 19)	NO	YES	YES
Zero point limit (Code 48 - d5)	NO	YES	YES
Lag time	NO	YES	YES
Leakage limit	NO	NO	YES

Parameter	Reset Code 36		
	Diag	Std	DS
Valve end position limit (on/off valve)	NO	The *Type of application* is reset to *Control valve.*	
Travel time assessment limit (on/off valve)	NO		
Total valve travel limit (Code 24)	NO	YES	YES
Stem seal	NO	NO	YES
Alarm mode (Code 25)	NO	YES	YES
Activate limit 1 and 2	NO	YES	YES
Limit 1 and 2 (Code 26 and 27)	NO	YES	YES
Error message in case of … (Code 32 and 33)	NO	YES	YES
Permit 'More status available' bit	NO	NO	YES
… condensed state activated	NO	NO	NO
Threshold for recording	YES	YES	YES
Activate lower limit	NO	YES	YES
Lower limit	NO	YES	YES
Activate upper limit	NO	YES	YES
Upper limit	NO	YES	YES
[Device settings > Alarm setting > Status classification > Positioner]			
All classifications	NO	NO	YES
[Device settings > Alarm setting > Status classification > Valve]			
All classifications	NO	NO	YES
[Device settings > Alarm setting > Status classification > Actuator]			
All classifications	NO	NO	YES
[Device settings > Alarm setting > Status classification > Valve position]			
All classifications	NO	NO	YES
[Device settings > Alarm setting > Status classification > PST/FST)]			
All classifications	NO	NO	YES
[Device settings > Alarm setting > Status classification > On/off valve]	NO	The *Type of application* is reset to *Control valve.*	
All classifications			
[Device settings > Alarm setting > Status classification > Supply pressure]			
All classifications	NO	NO	YES
[Device settings > Alarm setting > Status classification > Logging]			
Supply pressure	NO	NO	YES
Friction change	NO	NO	YES

Parameter	Reset Code 36		
	Diag	Std	DS
Seat leakage	NO	NO	YES
Packing leakage	NO	NO	YES
Pneumatic leakage	NO	NO	YES
Actuator springs defect	NO	NO	YES
Manipulated variable range limitation	NO	NO	YES
Course of end position	NO	NO	YES
Positioner-valve linkage	NO	NO	YES
Manipulated variable range	NO	NO	YES
Course of manipulated variable range	NO	NO	YES
Partial stroke test (PST)	NO	NO	YES
Full stroke test (FST)	NO	NO	YES
On/off valve	NO	NO	YES
Code 50–58, 61, 63, 76, 81	NO	NO	YES
Binary input	NO	NO	YES
Data logger	NO	NO	YES
Internal solenoid valve/forced venting/supply pressure	NO	YES	YES
Min. interval for new logging of internal solenoid valve	NO	YES	YES
[Diagnostics > Data logger]			
Function	YES	YES	YES
Sampling time	YES	YES	YES
Triggered by	YES	YES	YES
Trigger value	YES	YES	YES
Trigger band	YES	YES	YES
Trigger condition	YES	YES	YES
Trigger lead time	YES	YES	YES
[Diagnostics > Monitoring/tests > Valve signature > Course of supply pressure]			
Threshold for recording	NO	YES	YES
[Diagnostics > Monitoring/tests > Histograms > Valve position histogram > Short-term monitoring]			
Sampling time	YES	YES	YES
[Diagnostics > Monitoring/tests > Histograms > Set point deviation histogram > Short-term monitoring]			
Sampling time	YES	YES	YES

Parameter	Reset Code 36		
	Diag	Std	DS
[Diagnostics > Monitoring/tests > Leakage sensor > Short-term monitoring]			
Sensitivity sound level	YES	NO	YES
[Diagnostics > Monitoring/tests > Dynamic tests > Valve dead band]			
Lower range value	YES	YES	YES
Upper range value	YES	YES	YES
Waiting time after step change	YES	YES	YES
No. until reversing	YES	YES	YES
[Diagnostics > Monitoring/tests > Dynamic tests > Partial stroke test (PST)]			
Test start (Code 49 - A2)	NO	NO	NO
Enter test interval (Code 49 - A3)	NO	YES	YES
Lower range value (Code 49 - d2)	NO	YES	YES
Upper range value (Code 49 - d3)	NO	YES	YES
Tolerance limit	NO	YES	YES
Activate ramp function (Code 49 - d4)	NO	YES	YES
Ramp time (decreasing) (Code 49 - d6)	NO	YES	YES
Ramp time (increasing) (Code 49 - d5)	NO	YES	YES
Settling time before starting test (Code 49 - d7)	NO	YES	YES
Waiting time after step change (Code 49 - d8)	NO	YES	YES
Sampling time (Code 49 - d9)	YES	YES	YES
Max. test duration (Code 49 - E7)	YES	YES	YES
Activate 'Max. breakaway time'	NO	YES	YES
Max. breakaway time	NO	YES	YES
Activate 'Perm. time until step end'	NO	YES	YES
Perm. time until step end	NO	YES	YES
Activate x monitoring (Code 49 - E0)	NO	YES	YES
x monitoring value (Code 49 - E1)	NO	YES	YES
Activate Δp out monitoring (Code 49 - A8)	NO	YES	YES
Δp out monitoring value (Code 49 - A9)	NO	YES	YES
Activate PST tolerance band monitoring (Code 49 - E5)	NO	YES	YES
PST tolerance band (Code 49 - E6)	NO	YES	YES

Parameter	Reset Code 36		
	Diag	Std	DS
[Diagnostics > Monitoring/tests > Dynamic tests > Full stroke test (FST)]			
Tolerance limit	NO	YES	YES
Activate ramp function	NO	YES	YES
Ramp time (increasing)	NO	YES	YES
Ramp time (decreasing)	NO	YES	YES
Settling time before starting test	NO	YES	YES
Waiting time after step change	NO	YES	YES
Sampling time	YES	YES	YES
Max. test duration	YES	YES	YES
Activate 'Max. breakaway time'	NO	YES	YES
Max. breakaway time	NO	YES	YES
Activate 'Perm. time until CLOSED position'	NO	YES	YES
Perm. time until CLOSED position	NO	YES	YES
[Diagnostics > Service/maintenance> Reset]			
Desired time until 'Reset diagnostic measured data' (Code 48 - h3)	NO	NO	YES

Frequently used abbreviations

e	Set point deviation
p_{out}	Signal pressure
p_s	Supply pressure
x	Valve position
x_0	Valve position in tight-closed position
w	Set point, reference variable

ATC	Air to close
ATO	Air to open
BE	Binary input
FST	Full stroke test
FV	Forced venting
INIT	Initialization
NE	NAMUR Recommendation
NP	Zero point
OHC	Operating hours counter
PST	Partial stroke test
SV	Solenoid valve

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