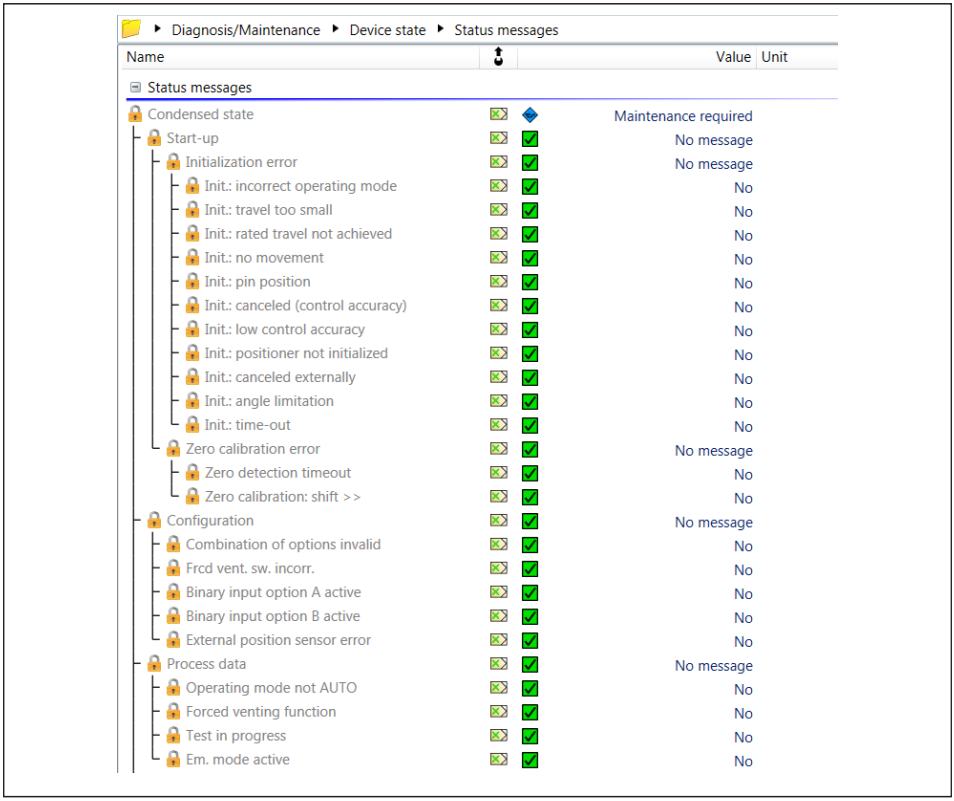
OPERATING INSTRUCTIONS

EB 8389-3 EN

Translation of original instructions



EXPERTplus Valve Diagnostics

TROVIS 3730-3 Smart Positioner

Firmware version 02.02.xx

Edition July 2025

Note on these mounting and operating instructions

These mounting and operating instructions assist you in mounting and operating the device safely. The instructions are binding for handling SAMSON devices. The images shown in these instructions are for illustration purposes only. The actual product may vary.

➔ For the safe and proper use of these instructions, read them carefully and keep them for later reference.

➔ If you have any questions about these instructions, contact SAMSON's After-sales Service (aftersalesservice@samsongroup.com).

Documents relating to the device, such as the mounting and operating instructions, are available on our website at ***www.samsongroup.com > Downloads > Documentation***.

Definition of signal words

⚠ DANGER

Hazardous situations which, if not avoided, will result in death or serious injury

⚠ WARNING

Hazardous situations which, if not avoided, could result in death or serious injury

NOTICE

Property damage message or malfunction

Note

Additional information

Tip

Recommended action

1 Safety instructions and measures

Intended use

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

EXPERTplus records the valve condition while the process is running (in 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 fully integrated into 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.

Reasonably foreseeable misuse

While the tests are being performed, the valve does not follow the set point. Instead, it is moved according to the specifications of the test procedure. Therefore, the tests can only be started when the conditions in the plant allow it.

Qualifications of operating personnel

The devices must be configured and set by trained and experienced personnel only. According to these operating instructions, trained personnel refers to individuals who are able to judge the work they are assigned to and recognize possible hazards due to their specialized training, their knowledge and experience as well as their knowledge of the applicable standards.

Personal protective equipment

No personal protective equipment is required.

Revisions and other modifications

Revisions or other modifications of the product are not authorized by SAMSON. They are performed at the user's own risk and may lead to safety hazards, for example. Furthermore, the product may no longer meet the requirements for its intended use.

Safety features

The software in offline mode has no influence on the connected device.

Warning against residual hazards

The software in online mode has a direct influence on the connected device and, as a result, on the valve. To avoid personal injury or property damage, plant operators and operating personnel must prevent hazards that could be caused in the control valve by the process medium, the operating pressure, the signal pressure or by moving parts by taking appropriate precautions. Plant operators and operating personnel must observe all hazard statements, warnings and caution notes in the referenced documents.

Responsibilities of the operator

Operators are responsible for proper use and compliance with the safety regulations. The operator is obliged to provide these operating instructions as well as the referenced documents to the operating personnel and to instruct them in proper operation. Furthermore, operators must ensure that operating personnel or third parties are not exposed to any danger.

Responsibilities of operating personnel

Operating personnel must read and understand these operating instructions as well as the referenced documents and observe the specified hazard statements, warnings and caution notes. Furthermore, operating personnel must be familiar with the applicable health, safety and accident prevention regulations and comply with them.

Referenced standards, directives and regulations

None

Referenced documents

The following documents apply in addition to these operating instructions:

– Mounting and operating instructions (EB), safety manual (SH) and configuration manual (KH) for mounted device:
  ▶ EB 8484-3 and ▶ KH 8384-3
– Mounting and operating instructions for the associated control valve (actuator, valve and other valve accessories)

1.1 Notes on possible property damage

NOTICE

Valve malfunction due to a configuration and parameter settings that do not meet the requirements of the application.

Settings for the EXPERTplus valve diagnostics can be made in the TROVIS-VIEW software. In online mode of this software, the configuration and parameter settings take effect immediately in the connected positioner and affect the control valve as a result.

➔ Only activate the online mode when configurations, parameter settings and measured values are to be transferred from or to the device.

2 Operation

Operation using TROVIS-VIEW/DD/DTM/eDD/FDI

EXPERTplus allows the parameters to be viewed or changed using the TROVIS-VIEW software or DD/DTM/eDD.

- **TROVIS-VIEW** · SAMSON user interface used to configure various SAMSON devices
- **DTM** · Device type manager to describe the device and communication properties
- **DD/eDD** · Device description/enhanced device description
- **FDI** · Field Device Integration

Note

All parameter settings and configurations must also be downloaded onto the positioner before they can become effective.

2.1 On-site operation

Some parameters can be changed at the positioner as well as using the software. Refer to the mounting and operating instructions of the TROVIS 3730-3 Positioner (▶ EB 8484-3) for a list of all parameters that can be changed locally at the positioner.

2.2 Operation using TROVIS-VIEW

Operation using TROVIS-VIEW is described in these operating instructions. The following applies in this case:

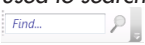
– The default settings of parameters are written in square brackets [ ].
– Operation applies to the 'Diagnosis' user level.

Note

The installation and operation of the TROVIS-VIEW software is explained in detail in the Operating Instructions ▶ EB 6661. These instructions are available on the Internet and in the [?] menu in TROVIS-VIEW.

Tip

The [Find...] function in the menu bar can be used to search for parameters:



3 Start-up

The positioner must be initialized to use the full scope of the valve diagnostics. During initialization, the positioner adapts itself optimally to the friction conditions and the signal pressure required by the control valve. The positioner can be initialized using one of the following initialization modes: MAX, NOM or MAN. Not all of the functions of EXPERTplus can be used when a positioner has been initialized in the SUB mode.

1. Connect the positioner to the configuration and operating software.
   ➔ The TROVIS-VIEW software on a computer can be connected to the positioner using an isolated USB interface adapter (order no. 1400-9740).
2. Put the positioner into operation as described in the Mounting and Operating Instructions ▶ EB 8484-3.

Tip

SAMSON recommends initialization with valve signature when the positioner is fitted with pressure sensors.

When initialization fails, the positioner generates a status message with the assigned status classification (see Chapter 3.1).

If a status message is generated during initialization, the group status 'Start-up' and 'Initialization' are also generated with the assigned status classification (see Chapter 3.1).

> Diagnosis/maintenance > Configuration > Status classification

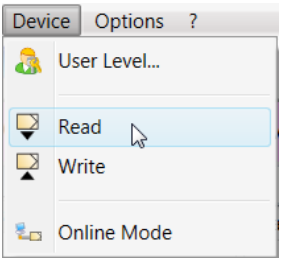
– Start-up:
 , [Highest classification]

– Initialization: ☑, ◈, ⚠, ▼, ⊗, [Highest classification]
– Init: incorrect operating mode: [☑], ◈, ⚠, ▼, ⊗
– Init: travel too small: ☑, [◈], ⚠, ▼, ⊗
– Init: rated travel not achieved: ☑, [◈], ⚠, ▼, ⊗
– Init: pin position: ☑, [◈], ⚠, ▼, ⊗
– Init: no movement: ☑, [◈], ⚠, ▼, ⊗
– Init: canceled (control accuracy): ☑, ◈, ⚠, ▼, ⊗, [Highest classification]
– Init: low control accuracy: ☑, ◈, ⚠, ▼, ⊗, [Highest classification]
– Positioner not initialized: ☑, ◈, [⚠], ▼, ⊗
– Init: canceled externally: ☑, [◈], ⚠, ▼, ⊗
– Init: angle limitation: ☑, ◈, ⚠, ▼, ⊗, [Highest classification]
– Init: timeout: ☑, ◈, ⚠, ▼, ⊗, [Highest classification]

> Diagnosis/maintenance > Device state > Status messages

– Start-up
– Initialization error
– Init: incorrect operating mode
– Init: travel too small
– Init: rated travel not achieved
– Init: no movement
– Init: pin position
– Init: canceled (control accuracy)
– Init: low control accuracy
– Init: positioner not initialized
– Init: canceled externally
– Init: angle limitation
– Init: timeout

3. Read out positioner data.
   ➔ In TROVIS-VIEW: select menu [Device > Read].



3.1 Signal pressure limitation

Requirements for the use of the 'Signal pressure limitation' function:

– The positioner has pressure sensors.
– The pressure limitation ensures that the pressure in the actuator does not exceed the maximum permissible pressure for the actuator.

The tight-closing function must be activated ('Lower end position' parameter = "Active") to allow the signal pressure limitation to work.

TROVIS 3730-3 > Start-up

– Pressure limit: 2.5 to 7.0 bar [4.7 bar]

TROVIS 3730-3 > Configuration > Set point processing

– Lower end position: **[Active]**

4 Device state

4.1 Information parameters and limits

[> Diagnosis/maintenance > Device state] folder contains information parameters on the positioner state and the limits used to generate status messages.

Pressure sensors

Information parameters only displayed when the positioner is fitted with the pressure sensors:

– 'OUTPUT 38: pressure':
current pressure at output 138
– 'Supply pressure':
current supply pressure
– 'Min. supply pressure':
lowest supply pressure
– 'Time stamp for min. supply pressure'
Time at which the pressure displayed in 'Min. supply pressure' occurred
– 'Max. supply pressure':
highest supply pressure
– 'Time stamp for max. supply pressure'
Time at which the pressure displayed in 'Max. supply pressure' occurred

> Configuration > Options > Pressure sensors
– Pressure sensors installed: Yes, [No]

Stress factor

The stress factor range is directly linked to the load cycle histogram (see Chapter 5.1.4).

The load on the bellows and/or packing can be read from the 'Dynamic stress factor' parameter.

– 'Dynamic stress factor'
– 'Stem seal'

> Diagnosis/maintenance > Device state
– Stem seal: Self-adjusting, Adjustable, Bellows, Other, [Not selected]

Total valve travel

– 'Total valve travel': totaled full valve travel cycle
– 'Total valve travel limit': the 'Total valve travel' status message is generated when the total valve travel exceeds the limit.

> Diagnosis/maintenance > Device state
– Total valve travel: 1000 to 90,000,000, [1,000,000]

Set point deviation

– 'Lag time for set point deviation': the lag time is determined during initialization. It is the reset criterion for the 'Set point deviation' status message. A transit time of less than 180 s determined during initialization causes the 'Lag time of set point deviation' to be set to 30 s. A transit time of 180 s or more determined during initialization causes the 'Lag time of set point deviation' to be set to six times the transit time.

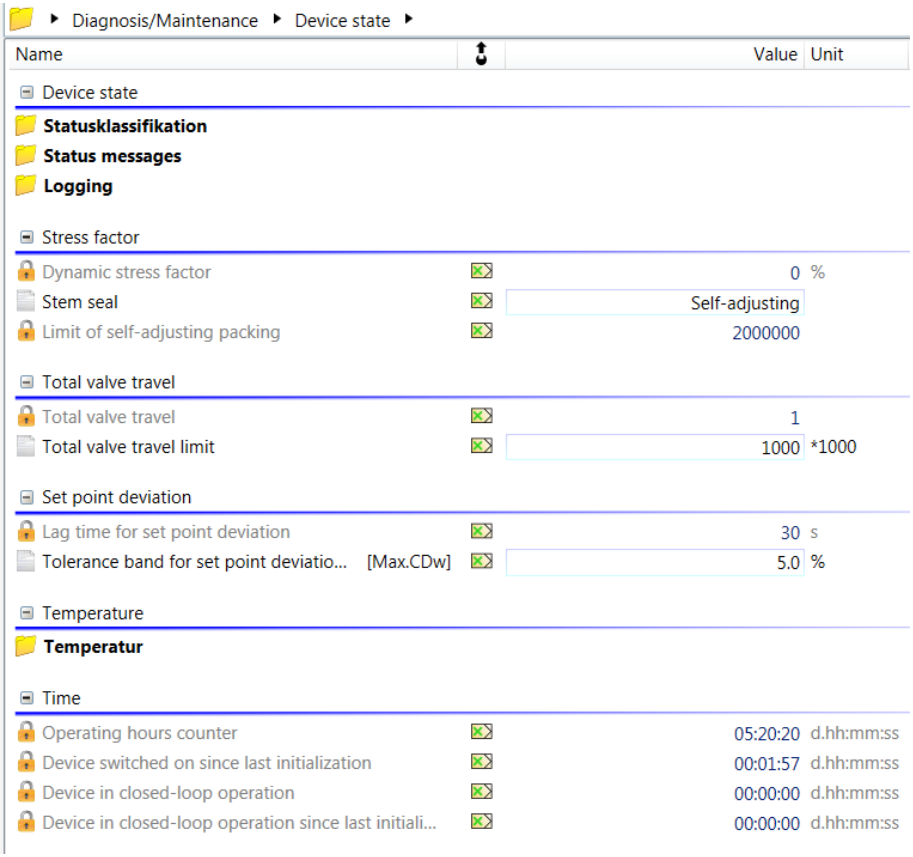


Fig. 1: *> Diagnosis/maintenance > Device state*

– 'Tolerance band for set point deviation +/-': a set point deviation is recognized as a system deviation when the valve position deviates from the set point by the value adjusted in this parameter.

> Diagnosis/maintenance > Device state

– Tolerance band for set point deviation +/-: 0.1 to 10.0 %, [0.5 %]

Temperature

– See Chapter 4.5 for [Temperature] folder.

Time

– 'Operating hours counter'
– 'Device switched on since last initialization'
– 'Device in closed-loop operation'
– 'Device in closed-loop operation since last initialization'

Counter

– 'Number of initializations'
– 'Number of zero calibrations'

Save

– 'Diagnostic data': the diagnostic data are saved in a non-volatile memory (EEPROM).

4.1.1 Reset

➔ See Table 1

4.2 Status classification

A status classification is assigned to the status messages of the EXPERTplus valve diagnostics. This assigned status appears when a status message is generated.

Table 1: *Reset the values in [> Diagnosis/maintenance > Device state]*	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset information parameters without operating hours counter	NO	YES	YES	NO	NO
Reset operating hours counter	NO	NO	NO	NO	NO
Reset limits	NO	YES	YES	NO	[1]

[1] Reset depending on limit

The following classifications are possible:

Priority

- **No message**
  If an event is classified as "No message", this event does not have any affect on the condensed state.
- **Maintenance required**
  The positioner still performs its control task (with restrictions). A maintenance demand 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 operating outside the specified operating conditions or has not yet been initialized.
- **Function check**
  Test or calibration procedures are performed in the positioner. The positioner is temporarily unable to perform its control task as long as the procedure is taking place.
- **Failure**
  The positioner cannot perform its control task due to a malfunction in the positioner itself or in one of its peripherals.

- **Highest classification**
  Status classification of a group status (see Chapter 4.3.1). The group status depends on the status classification assigned to the status messages: the status message with the highest classification determines the group status.

Note

In the 'On-site: write' TROVIS-VIEW user level, the active status messages are visible. In some cases, only the active group status is visible without the assigned status messages.

The status classification is predetermined in the [> Diagnosis/maintenance > Configuration > Status classification] folder. All status messages are assigned to a status by default.

Note

The 'Out of specification' status is assigned to a positioner that has not yet been initialized.

4.2.1 Reset

➔ See Table 2

Table 2:
Reset the status classification in [> Diagnosis/maintenance > Configuration > Status classification]

	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset status classification	NO	NO	YES	NO	NO

4.3 Status messages

The valve diagnostics integrated into the positioner generate classified status messages. All status messages with their assigned status are listed in the [> Diagnosis/maintenance > Device state > Status classification] folder.

Note

The '☑ No message' status is generated when:

– *The conditions to generate a status message are not fulfilled.*
– *The conditions to generate a status message are fulfilled, but the status message is assigned the 'No message' status.*

➔ SAMSON recommends following the instructions listed in the Appendix when a status message occurs.

4.3.1 Group and condensed states

To provide a better overview on the individual status messages, various status messages are summarized in a **group status**. If a status message assigned to a group is active, the group status is generated according to the predefined status classification.

The **condensed state** is summary of all status messages. To provide a better overview on the condition of the valve, all status messages are summarized in a condensed state which is made up from a summary of all classified messages in the positioner. The condensed state is a summary of all status messages issued by the device. The status message with the highest priority determines the condensed state.

Tip

The condensed state is indicated on the right-hand corner of the status bar in TROVIS-VIEW.

4.4 Logging

EXPERTplus can log up to 400 events. They are listed in the [> Diagnosis/maintenance > Device state > Logging] folder together with additional information on the event and the time it occurred.

When the 'Log 'No message' (NAMUR classification)' parameter is set to 'Yes', messages are logged even when their status classification is set to 'No message'.

> Diagnosis/maintenance > Configuration
– Log 'No message' (NAMUR classification): [Yes], No

Logging starts automatically. It does not need to be activated by the user.

For example, the following events are logged:

– The positioner was started up.
– The positioner was successfully initialized.
– EXPERTplus generates a status message.
– A generated status message has been canceled.
– A test was successfully completed.

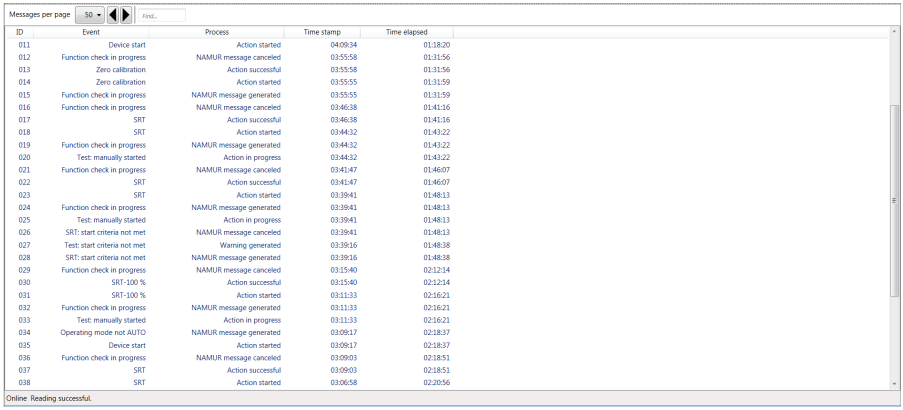
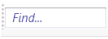


Fig. 2: *> Diagnosis/maintenance > Device state > Logging*

Tip

Use [Find...] function to find a certain event:



Note

When the 'Log 'No message' (NAMUR classification)' parameter is activated, events are also logged even when their status classification is set to 'No message'. The activation does not affect the issuing of status messages.

4.4.1 Reset

➔ See Table 3

Table 3:
Reset the logging in [> Diagnosis/maintenance > Device state > Logging]

	'Reset logging'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset logging	YES	NO	YES	YES	NO	NO

4.5 Temperature

The temperature inside the device is displayed:

– 'Temperature inside device': current temperature inside the device
– 'Min. temperature inside device': the lowest temperature inside the device while in service
– 'Max. temperature inside device': the highest temperature inside the device while in service
– 'Minimum temperature limit': the 'Temperature inside device below min. limit' status message is generated with the assigned status classification when the temperature inside the device falls below the limit. The status message is cleared as soon as the temperature rises above the limit again.
– 'Maximum temperature limit': the 'Temperature inside device above max. limit' status message is generated with the assigned status classification when the temperature inside the device exceeds the limit. The status message is cleared as soon as the temperature falls below the limit again.

i ***Note***

The 'Minimum temperature limit' and 'Maximum temperature limit' parameters are set to –60 °C and 80 °C respectively by default. These settings can only be changed in the 'Customer expert' user level.

4.5.1 Reset

➔ See Table 4

Table 4:
Reset the temperature values in [> Diagnosis/ maintenance > Device state > Temperature]

	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset temperature values	NO	NO	[1]	NO	NO

[1] YES = 'Minimum temperature limit' and 'Maximum temperature limit'
NO = 'Temperature inside device', 'Min. temperature inside device' and 'Max. temperature inside device'

5 Monitoring

The monitoring function compiles data while the process is running without disrupting the process. The data are saved and analyzed in the positioner, i.e. the positioner follows the set point to position the valve. A classified status message is generated when the positioner detects an event.

5.1 Histograms

Histograms are a statistical analysis. The tests for the histograms are performed by the positioner automatically in the AUTO and SAFE modes. For this purpose, data are logged every second and saved in a non-volatile memory every 24 hours.

Data logging and analysis do **not** need to be activated.

EXPERTplus has histograms on the following topics:

– Valve position (see Chapter 5.1.2)
– Set point deviation (see Chapter 5.1.3)
– Load cycle (see Chapter 5.1.4)

The histograms can be displayed for different monitoring periods. The monitoring periods are defined in the drop-down menu and using the slider at the bottom of the histogram:

– Drop-down menu: [Service life], Days, Weeks, Months, Years
– Slider:

  Days: [Today], Yesterday, Day before yesterday, 3 days ago, …, 6 days ago

  Weeks: [This week], Last week, Week before last, 3 weeks ago

  Months: [This month], Last month, Month before last, 3 months ago, …, 11 weeks ago

  Years: [This year], Last year, Year before last, 3 years ago, …, 5 years ago

5.1.1 Reset

The valve position, set point deviation and load cycle histograms are all reset. It is not possible to reset single histograms.

➔ See Table 5

Table 5: *Resetting the valve position, set point deviation and load cycle histograms*

	'Reset histograms'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset measured data	YES	YES	YES	YES	NO	NO

5.1.2 Valve position

The valve position histogram provides information about the range in which valve mainly works during its service life and whether the operating range is possibly shifting.

The positioner records the valve position every second and arranges the data in predefined valve position classes. The distribution among the valve position classes is shown in a bar graph.

Analysis and monitoring

The first and last class indicate how often the 'End position w ≤' and 'End position w ≥' functions have been triggered.

– The 'End position w ≤' function causes the valve to move to the closed position when the valve position reaches an adjustable set point.

– The 'End position w ≥' function causes the valve to move to the open position when the valve position reaches an adjustable set point.

The functions can be adjusted in the [> Configuration > Set point processing] folder.

A valve position that is mainly located close to the closed or open position pinpoint to a valve that is too large or too small.

➔ SAMSON recommends checking the valve sizing.

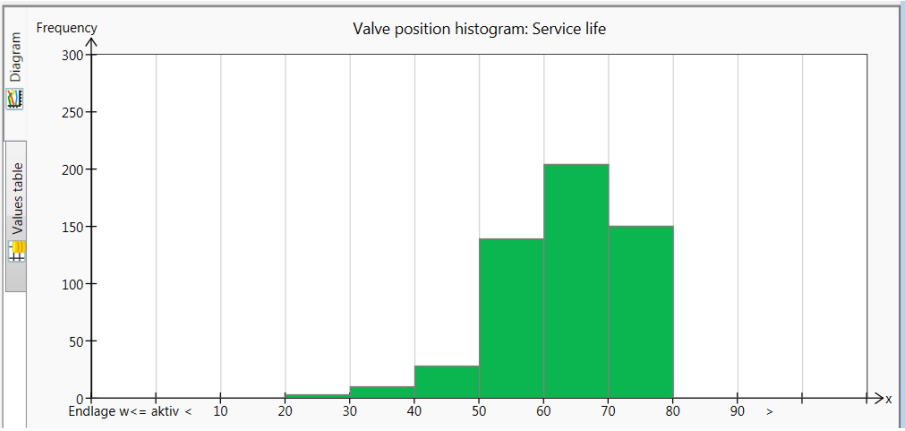


Fig. 3: *> Diagnosis/maintenance > Monitoring > Histograms > Valve position*

5.1.3 Set point deviation

The set point deviation histogram provides information on to which extent a set point deviation has occurred and whether faults may occur due to a restricted working range.

The positioner records the set point deviation every second and arranges the data in predefined classes. The distribution among the set point deviation classes is shown in a bar graph.

Analysis and monitoring

Ideally, the set point deviation should be as close to 0 % as possible.

Set point deviations greater than 1 % occurring within a short span of time pinpoint to a limitation of the upper working range.

➔ SAMSON recommends checking the attachment.

Set point deviations smaller than 1 % occurring within a short span of time pinpoint to a limitation of the lower working range or to seat leakage.

➔ SAMSON recommends checking the attachment as well as the seat and plug for wear.

If almost all set point deviations during the short-term monitoring are greater than 1 % or smaller than –1 %, this may indicated that the actuator or valve stem is jammed.

➔ SAMSON recommends checking the plug stem for external influences that could be blocking it.

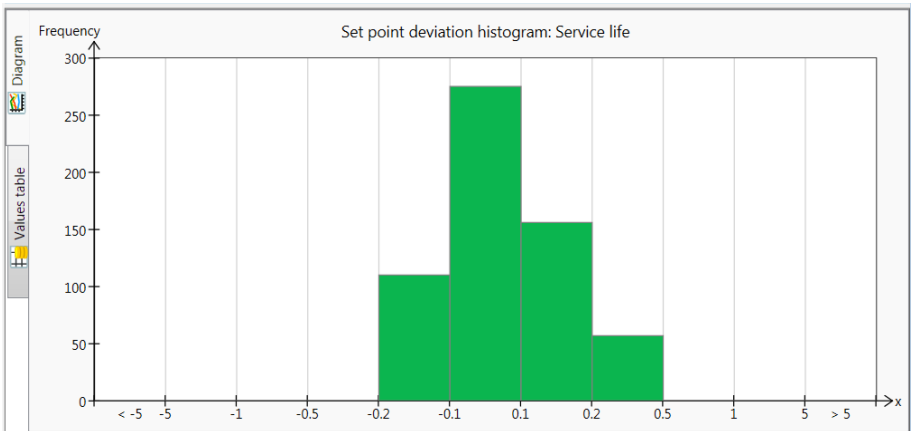


Fig. 4: *> Diagnosis/maintenance > Monitoring > Histograms > Set point deviation*

5.1.4 Load cycle

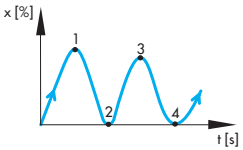
The load cycle histogram provides a statistical analysis of the cycles that the valve has moved through. As a result, the cycle counter also provides information on the dynamic stress acting on the bellows seal and/or packing.

The positioner records the height of the cycles that the valve has moved through taking the selected stem seal into account.

The cycles are assigned to classes. The distribution showing how often the cycle occurred within a class is shown in a bar graph.

Note

A valve cycle span starts at the point where the valve stroke changes direction until the point where it changes direction again.



> Diagnosis/maintenance > Device state

– Stem seal: [Not selected], Self-adjusting, Adjustable, Bellows, Other

NOTICE

No analysis of 'Dynamic stress factor' with 'Stem seal' = "Not selected" (= default setting).

Set 'Stem seal' parameter to allow an analysis of the load cycle histogram to be performed.

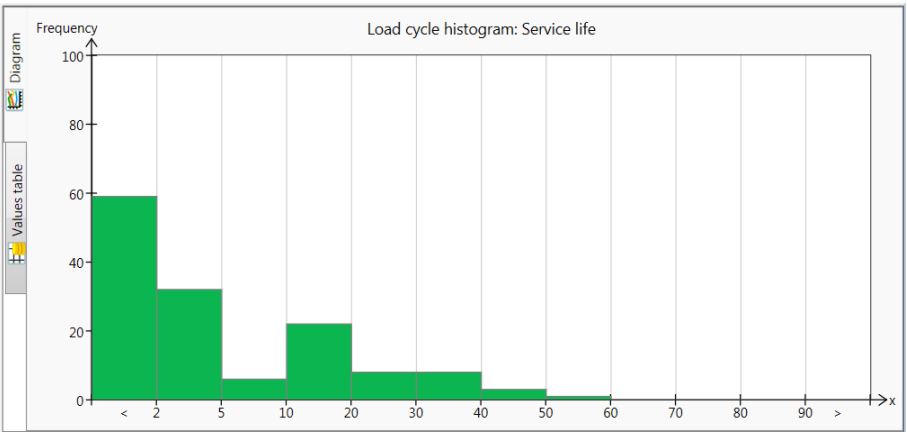


Fig. 5: *> Diagnosis/maintenance > Monitoring > Histograms > Load cycle*

Analysis and monitoring

The load on the bellows and/or packing can be read from the 'Dynamic stress 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 'Dynamic stress factor exceeded' status message is generated with the assigned status classification whenever:

– The number of measured cycle spans exceeds 2,000,000 when 'Self-adjusting' is selected as the stem seal.
– The number of measured cycle spans exceeds 800,000 when 'Adjustable' is selected as the stem seal.
– The number of measured cycle spans exceeds 90 % of the 'Max. cycle count' when 'Other' is selected as the stem seal.
– The number of measured cycle heights exceeds 8473930 when 'Bellows' is selected as the stem seal.

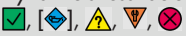
Tip

The level of stress that the packing is subjected to depends on other factors besides load cycles, e.g. on the process medium and the operating conditions. Therefore, in the 'Customer expert' user level, it is possible to adapt the limits to trigger the 'Dynamic stress factor exceeded' status message as required.

> Diagnosis/maintenance > Device state

– Dynamic stress factor

> Diagnosis/maintenance > Configuration > Status classification

– Dynamic stress factor exceeded: 

> Diagnosis/maintenance > Device state > Status messages

– Dynamic stress factor exceeded

➔ SAMSON recommends checking the condition of the packing when the status message is generated to prevent external leakage.

5.2 Course of end position

Data are recorded in the background regardless of the operating mode selected when the conditions for logging data are fulfilled (see Chapters 5.2.1 and 5.2.2). Data logging does not need to be activated.

The course of end position function records the measured data when the valve moves to the end position:

– Valve position
– Temperature
– Time stamp of operating hours counter

The new recorded end position is compared to the last saved end position. If the valve position deviates from the last value by 0.3 %, the data of the new end position are saved.

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

The positioner saves the valve positions in a circular buffer, which holds 30 measured values at one time.

Analysis and monitoring

The 'Course of lower end position' and 'Course of upper end position' status messages are generated with the assigned status classification whenever a new recorded end position deviates from the reference value by the 'Threshold for end position shift'. The reference value is determined during initialization (see Chapters 5.2.1 and 5.2.2). It is shown as a straight line in the graph.

> Diagnosis/maintenance > Monitoring > Histograms > Course of end position

– Threshold for end position shift:
0.3 to 100.0 %, [5.0 %]

Note

When temperature fluctuations occur and with valves with a long insulating section, the 'Course of lower end position' and 'Course of upper end position' status messages may be generated at an early stage.

5.2.1 Course of lower end position

To record data for the course of lower end position (behavior while the valve is in the tight shut position), the following conditions must exist:

– The positioner was initialized in the MAX or NOM mode.
– The tight-closing function is active ('Lower end position' parameter = 'Activated').

> Configuration > Set point processing

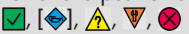
– Lower end position: **[Activated]**

Note

When the end position function is active, the valve shuts off tightly as soon as the set point is lower or equal to the value entered in 'End position w <='.

The reference value for the course of the lower end position is reference zero. This is determined during a MAX or NOM initialization and during a zero calibration.

> Diagnosis/maintenance > Configuration > Status classification

– Lower end position shifted:


> Diagnosis/maintenance > Device state > Status messages

– Lower end position shifted

The generation of the 'Lower end position shifted' status message in combination with a shift of the course of the end position downward pinpoints to signs of wear between seat and plug in metal-seated valves.

➔ SAMSON recommends checking the seat and plug for wear.

Note

The 'Lower end position shifted' status message is generated briefly after the initialization of soft-seated valves for design reasons. The soft seal settles after a few load cycles causing zero to be shifted. In these valves, a repeated generation of the status message

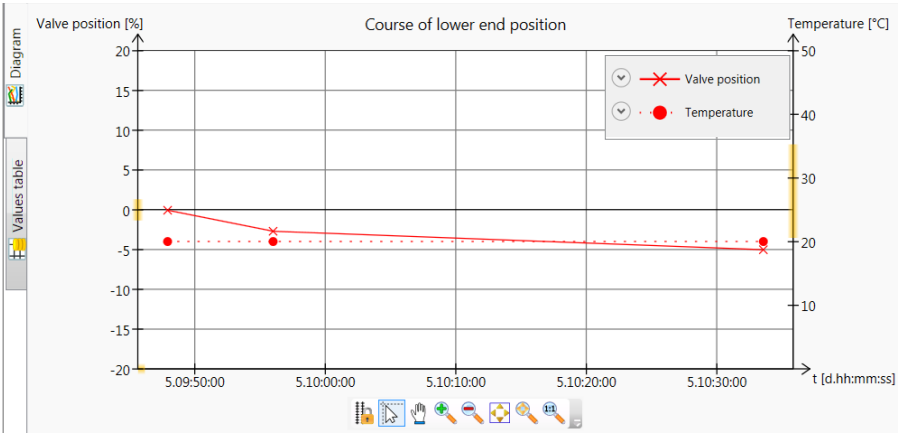


Fig. 6: *> Diagnosis/maintenance > Monitoring > Histograms > Course of end position > Course of lower end position*

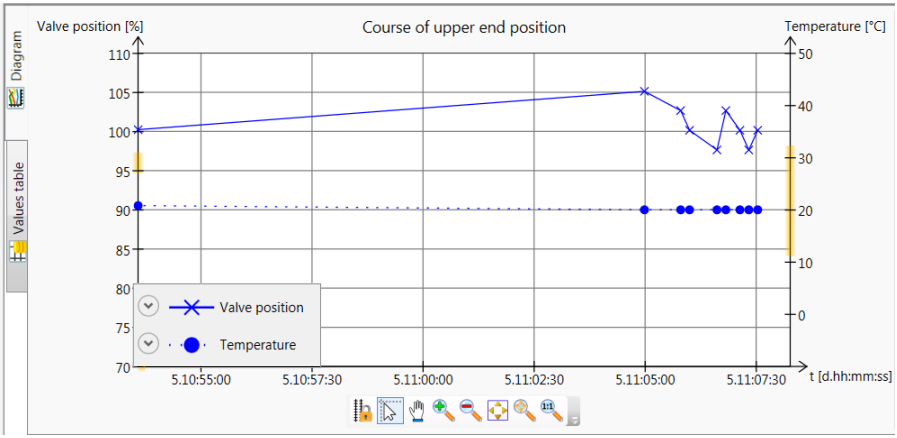


Fig. 7: *> Diagnosis/maintenance > Monitoring > Histograms > Course of end position > Course of upper end position*

after a long time service first indicates signs of wear.

The generation of the 'Lower end position shifted' status message in combination with a shift of the course of the end position upward pinpoints to a blockage of the plug stem, e.g. due to dirt particles.

➔ SAMSON recommends checking the plug stem for mechanical blockage.

5.2.1.1 Reset

➔ See Table 6

5.2.2 Course of upper end position

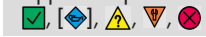
The positioner must be initialized in the MAX mode to allow the course of end position data to be recorded.

The reference value for the course of the upper end position is the travel at the OPEN valve position. It is determined only in the MAX initialization mode.

Analysis and monitoring

If the analysis of the course of the upper end position pinpoints to a fault, the positioner generates the 'Upper end position shifted' status message with the assigned status classification.

> Diagnosis/maintenance > Configuration > Status classification

– Upper end position shifted:


> Diagnosis/maintenance > Device state > Status messages

– Upper end position shifted

➔ SAMSON recommends checking the plug stem for mechanical blockage when the status message is generated.

Table 6: *Reset the course of end position*

		Zero calibration	'Reset course of end position'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset reference value	Lower end position	YES	NO	NO	YES	YES	NO	YES
	Upper end position	NO	NO	NO	YES	YES	NO	YES
Reset measured data	Lower end position	NO	YES	YES	YES	YES	NO	YES
	Upper end position	NO	YES	YES	YES	YES	NO	YES
Reset status message	Lower end position	YES	NO	YES	YES	YES	NO	NO
	Upper end position	NO	NO	YES	YES	YES	NO	NO

5.2.2.1 Reset

➔ See Table 6

5.3 Course of supply pressure

Requirements for the use of the 'Course of supply pressure' diagnostic function:

The positioner has pressure sensors (see nameplate of the positioner).

The supply pressure is recorded in the background, regardless of the operating mode selected, if the current supply pressure deviates from the last recorded value in the diagram by the amount specified in 'New recording threshold for supply pressure'. Data logging does not need to be activated.

> Diagnosis/maintenance > Monitoring > Course of supply pressure

– New recording threshold for supply pressure: 0.10 to 5.00 bar, [1.00 bar]

5.3.1 Reset

➔ See Table 7

Table 7: *Reset course of supply pressure*	'Reset course of supply pressure'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset measured data	YES	YES	YES	YES	NO	NO

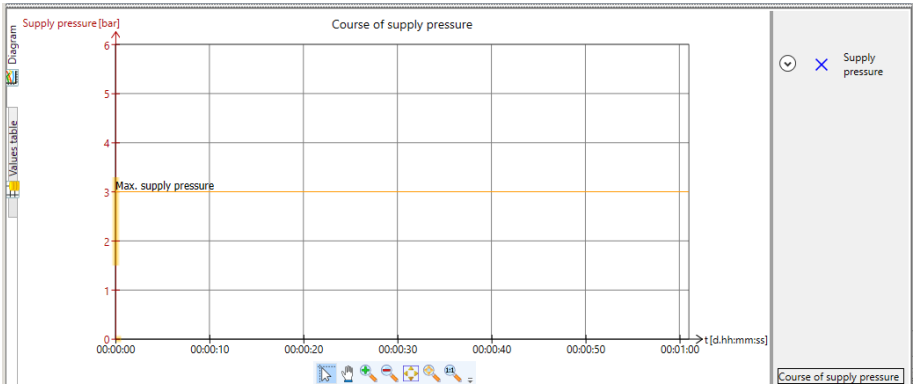


Fig. 8: *> Diagnosis/maintenance > Monitoring > Course of supply pressure*

5.4 Valve signature (valve signature without pressure sensors)

i ***Note***

The 'Valve signature IP' monitoring is only visible for positioners without pressure sensors. In contrast, the 'Valve signature' folder is shown for positioners with pressure sensors (see Chapter 5.5).

The valve signature plots the set point at the i/p converter as a function of valve position. The mean measuring points for supply and exhaust are shown.

Test requirement

– A single-acting actuator is mounted on the valve.

> **> Configuration > Identification > Actuator**
>
> – Principle of operation: **Single-acting**

– The positioner was successfully initialized in the MAX, NOM or MAN mode.

5.4.1 Recording reference graphs

During the plotting of the reference graph (Fig. 9), the valve is moved from the unpressurized end position until it is close to the maximum open position and back again. To perform this function, the pneumatic unit switches to open-loop control (control without feedback).

Recording the reference graph

The reference graph is automatically plotted after initialization when 'Init. with valve signature' = Yes.

> **> Start-up**
>
> – Init. with valve signature: **[Yes]**

If a reference graph does not exist, the reference test can be started manually, provided the conditions in the plant allow it (e.g. plant shutdown or service work in the workshop):

1. Switch to MAN mode.
   The 'Operating mode not AUTO' status message is generated based on its set status classification.

   > **TROVIS 3730-3**
   >
   > – Target operating mode: MAN

2. Start recording of reference graphs.
   'Function check' is activated as the condensed state.

   > **> Diagnosis/maintenance > Monitoring > Valve signature**
   >
   > **!** Start recording of reference graphs

i ***Note***

The plotting of the reference graph can be interrupted by the 'Stop test' parameter or by pressing the rotary pushbutton. This may be necessary when the test takes too long, e.g. control valves with large actuators.

After the reference graph has been plotted, the positioner remains in the MAN mode.

Analysis and monitoring

The positioner records the mean values for supply and exhaust. The 'Valve signature status' parameter indicates 'Valid without pressure sensor' when the valve signature is completed. The 'Valve signature status' parameter indicates 'Invalid' if the recorded measured values are not suitable for analysis. A detailed description on the insufficient recording for plotting the reference graph can be found in the 'Result of last valve signature' parameter.

> Diagnosis/maintenance > Monitoring > Valve signature

– Valve signature status: Invalid, Valid with pressure sensor, Valid without pressure sensor
– Result of the last valve signature: Not executed, Successful, Canceled (man.) etc.

Note

The valve signature can be recorded again at any time and compared with the reference (see Chapter 6.4) to assess the valve performance.

5.4.1.1 Reset

➔ See Table 8

5.4.2 Monitoring

The positioner records the set point at the i/p converter ('Valve signature IP monitoring' diagram) during closed-loop operation.

Data are recorded in the background regardless of the operating mode selected if a reference graph has already been plotted. Data logging does not need to be activated.

Analysis and monitoring

The positioner monitors the supply pressure and generates one of the following status messages in case of an incident:

– 'Spring possibly broken': A reduced spring force has been detected in a fail-close control valve. The monitoring values are lower than those of the reference test. Both lines start to rise slightly at the same time.
– 'Pneumatic leakage': The positioner has detected significant leakage in the pneumatic system. The measured values are higher than those in the reference test

Table 8:
Resetting the valve signature status (valve signature IP)

	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset measured data	YES	YES	YES	YES	YES

after the valve is opened by a certain amount.

The status messages are cleared when the supply pressure falls below or exceeds the pressure limit again.

> Diagnosis/maintenance > Configuration > Status classification

– Spring possibly broken: ☑, [◈], ⚠, ▼, ⊗

> Diagnosis/maintenance > Device state > Status messages

– Spring possibly broken

➔ SAMSON recommends checking the supply pressure, supply pressure regulator and pneumatic connections after a 'Pneumatic leakage' status message has been generated.

A 'Spring possibly broken' status message points to reduced spring compression in the actuator. In such cases, SAMSON recommends performing the valve signature test to verify the result (see Chapter 6.5).

5.4.2.1 Reset

➔ See Table 9

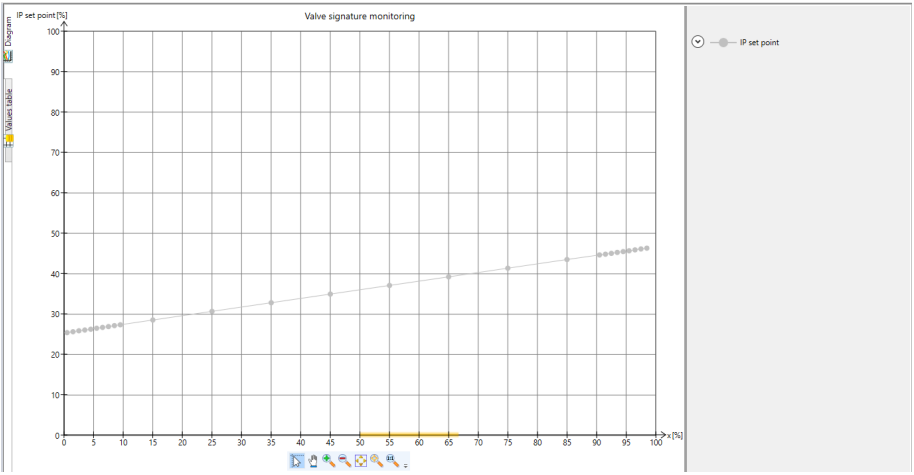


Fig. 9: *> Diagnosis/maintenance > Monitoring > Valve signature > Monitoring*

Table 9: *Resetting the valve signature monitoring (valve signature IP)*	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset measured data (monitoring)	YES	YES	YES	NO	NO
Reset status message	NO	NO	NO	YES	YES

5.5 Valve signature (valve signature with pressure sensors)

i ***Note***

The 'Valve signature' monitoring is only visible when the positioner is fitted with pressure sensors. In contrast, the 'Valve signature IP' folder is shown for positioners without pressure sensors (see Chapter 5.4).

The valve signature records the signal pressure during the supply and exhaust process in relation to the valve position. It also determines lower and upper bench range values.

All diagnostic functions dependent on the signal pressure are based on the valve signature.

Test requirement

– A single-acting actuator is mounted on the valve.

> **> Configuration > Identification > Actuator**
>
> – Principle of operation: **Single-acting**

– The positioner was successfully initialized in the MAX, NOM or MAN mode.

5.5.1 Recording reference graphs

During the plotting of the reference graph (Fig. 10), the valve is moved from the unpressurized end position until it is close to the maximum open position and back again. To perform this function, the pneumatic unit switches to open-loop control (control without feedback).

Recording the reference graph

The reference graph is automatically plotted after initialization when 'Init. with valve signature' = Yes.

> **> Start-up**
>
> – Init. with valve signature: **[Yes]**

If a reference graph does not exist, the reference test can be started manually, provided the conditions in the plant allow it (e.g. plant shutdown or service work in the workshop):

1. Switch to MAN mode.
   The 'Operating mode not AUTO' status

message is generated based on its set status classification.

TROVIS 3730-3

– Target operating mode: MAN

2. Start recording of reference graphs. 'Function check' is activated as the condensed state.

> Diagnosis/maintenance > Monitoring > Valve signature

! Start recording of reference graphs

Note

The plotting of the reference graph can be interrupted by the 'Stop test' parameter or by pressing the rotary pushbutton. This may be necessary when the test takes too long, e.g. control valves with large actuators.

After the reference graph has been plotted, the positioner remains in the MAN mode.

Analysis and monitoring

The positioner records the supply and exhaust data and plots their lines in a graph. It then determines the characteristic values listed below:

- 'Average hysteresis': Average signal pressure difference in relation to the spring range
- 'Min. hysteresis': Minimum signal pressure difference in relation to the spring range
- 'Max. hysteresis': Maximum signal pressure difference in relation to the spring range
- 'Lower spring range value': Signal pressure p_{out} at minimum supply
- 'Upper bench range value': Signal pressure p_{out} at maximum supply

The 'Valve signature status' parameter indicates 'Valid with pressure sensors' when the valve signature is completed. The 'Valve signature status' parameter indicates 'Invalid' if the recorded measured values are not suitable for analysis. A detailed description on the insufficient recording for plotting the reference graph can be found in the 'Result of last valve signature' parameter.

The 'Valve signature failed' status message is generated with the assigned status if the reference recording is canceled.

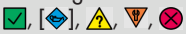
Table 10: *Resetting the valve signature status (valve signature)*

	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset status message	NO	NO	NO	YES	YES

> Diagnosis/maintenance > Monitoring > Valve signature

– Valve signature status: Invalid, Valid with pressure sensor, Valid without pressure sensor
– Result of the last valve signature: Not executed, Successful, Canceled (man.) etc.

> Diagnosis/maintenance > Configuration > Status classification

– Valve signature failed:


> Diagnosis/maintenance > Device state > Status messages

– Valve signature failed

Note

The valve signature can be recorded again at any time and compared with the reference (see Chapter 6.5) to assess the valve performance.

5.5.1.1 Reset

➔ See Table 10

5.5.2 Monitoring

The positioner records the set point at the i/p converter (IP set point), the pressure and signal pressure for exhaust and supply during closed-loop operation (see Fig. 10).

Data are recorded in the background regardless of the operating mode selected if a reference graph has already been plotted. Data logging does not need to be activated.

Analysis and monitoring

The positioner monitors the supply pressure and generates one of the following status messages in case of an incident:

– 'No supply press.' if the supply pressure falls below 0.1 bar.
– 'Low supply pressure' if the supply pressure is below 'Lower press. limit', but above 0.1 bar.
– 'Supply pressure > 7 bar'
– 'Spring possibly broken': A reduced spring force has been detected in a fail-close control valve. The monitoring values for the IP set point are lower than those of the reference test. Both lines start to rise slightly at the same time.
– 'Pneumatic leakage': The positioner has detected significant leakage in the pneumatic system. The measured values of the IP set point are higher than those in the reference test after the valve is opened by a certain amount.

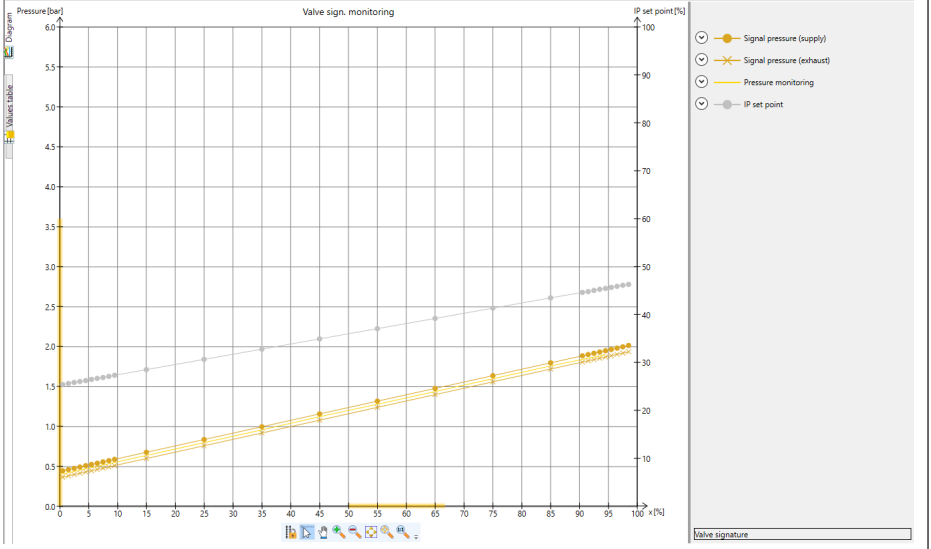


Fig. 10: > *Diagnosis/maintenance > Monitoring > Valve signature > Monitoring*

The status messages are cleared when the supply pressure falls below or exceeds the pressure limit again.

> Diagnosis/maintenance > Configuration > Status classification

– No supply press.: ☑, ◆, [⚠], ▼, ⊗
– Low supply pressure: ☑, [◆], ⚠, ▼, ⊗
– Supply pressure > 7 bar: ☑, ◆, [⚠], ▼, ⊗
– Spring possibly broken: ☑, [◆], ⚠, ▼, ⊗
– Pneumatic leakage: [Highest classification]

> Diagnosis/maintenance > Device state > Status messages

– No supply pressure
– Low supply pressure
– Supply pressure > 7 bar
– Spring possibly broken
– Pneumatic leakage

➔ SAMSON recommends checking the supply pressure, supply pressure regulator and pneumatic connections after a status message 'No supply pressure', 'Supply pressure <7 bar' or 'Pneumatic leakage' has been generated.

A 'Spring possibly broken' status message points to reduced spring compression in the actuator. In such cases, SAMSON recommends performing the valve signature test to verify the result (see Chapter 6.5).

5.5.2.1 Reset

➔ See Table 11

5.5.3 Friction

Analysis of the pressure only possible when the positioner is fitted with the optional pressure sensors (see positioner nameplate).

The positioner calculates the friction during closed-loop operation and compares it with the friction determined when the reference graph was plotted (see Fig. 11).

Data are recorded in the background regardless of the operating mode selected provided a reference graph has already been plotted. Data logging does not need to be activated.

Table 11:
Resetting the valve signature monitoring (valve signature)

	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset measured data (monitoring)	YES	YES	YES	NO	NO
Reset status message	NO	NO	NO	YES	YES

5.5.4 Analysis and monitoring

The friction for the total range of the valve, the mid valve position and for the ranges near the closed position are compared.

The positioner calculates the friction during closed-loop operation from the plotted supply and exhaust lines 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

The valve must not move too quickly. Otherwise, it is not possible to compare the calculated friction with the reference friction.

> Diagnosis/maintenance > Configuration > Status classification

– Friction change (open pos.): ☑, [◈], ?, ▼, ⊗
– Friction change (mid-pos.): ☑, [◈], ?, ▼, ⊗
– Friction change (closed pos.): ☑, [◈], ?, ▼, ⊗

> Diagnosis/maintenance > Device state > Status messages

– Friction change (open pos.)
– Friction change (mid-pos.)
– Friction change (closed pos.)

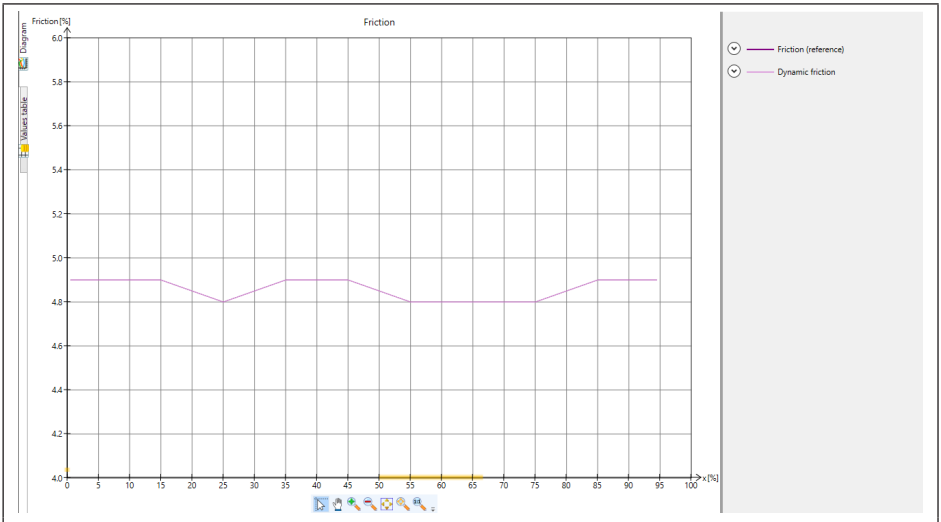


Fig. 11: *> Diagnosis/maintenance > Monitoring > Valve signature > Reports and diagrams > Friction*

6 Tests

Similar to the monitoring function, data are compiled, saved and analyzed in the positioner for the tests. **However, in this case, the valve position is not determined by the set point, but by the active test.** The 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, the tests, except for partial stroke testing, can only be performed in the MAN operating mode.

i ***Note***

An active test is stopped and the positioner changes to the fail-safe position when the electrical signal falls below a certain level or when the forced venting function is triggered.

6.1 Partial stroke test (PST)

i ***Note***

Either the term 'step response test (SRT)' or 'partial stroke test (PST)' is used depending on the software version. The terms are synonymous and are used to describe the same test.

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. A shut-off valve normally in its end position can be prevented from seizing up or getting jammed. The initial breakaway torque must first be overcome after the valve starts to move from its end position. The initial breakaway torque depends on the plug/seat seal, deposits on the plug, the process medium and friction at the valve trim. After the initial breakaway torque has been overcome, it can be assumed that the valve is able to close completely. The recording of the test results additionally allows an analysis of the dynamic control response.

During the partial stroke test, the valve moves from its current operating point by a defined change in travel and back to the initial position again. The change in travel is calculated from the 'Start value' and 'Step height'.

The change in travel can be performed either in steps or in a ramp function (Fig. 12). The test is performed with the ramp function when the ramp times ('Ramp 1' and 'Ramp 2') are set to ≠ 0 s.

The test starts after reaching the 'Start value' and the 'Delay time' has elapsed. Starting from the 'Start value', the valve moves through the 'Step height' in the 'Test direction'. The valve remains in this position for the time defined in 'Delay time' before performing a second step change in the opposite direction to the operating point. The 'Sampling rate' defines the time interval between which the measured values are recorded during the test.

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

– Start value: –20 to 120 %, [100 %]
– Step height: 2 to 100 %, [10 %]
– Test direction: [Minus], Plus
– Ramp 1: 0 to 9999 s, [60 s]
– Ramp 2: 0 to 9999 s, [6 s]
– Waiting time: can only be selected in the 'Customer expert' user level
– Sampling rate (not write-enabled)

6.1.1 Test cancellation criteria

Various test cancellation conditions provide additional protection against the valve slamming shut or moving further than the step height. The positioner cancels the partial stroke test when one of the following cancellation conditions is fulfilled:

Time

– 'Canceled: max. test duration': the test is canceled when the maximum permissible test duration is reached.

  > Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

  – Canceled: max. test duration (not write-enabled)

– 'Canceled: max. dead time': the test is canceled when the 'Delay time' has elapsed without the valve having moved by the value 'Dead time limit determined'.

  This cancellation criterion only takes effect when 'Dead time limit determined' is set to ≠ 0 %.

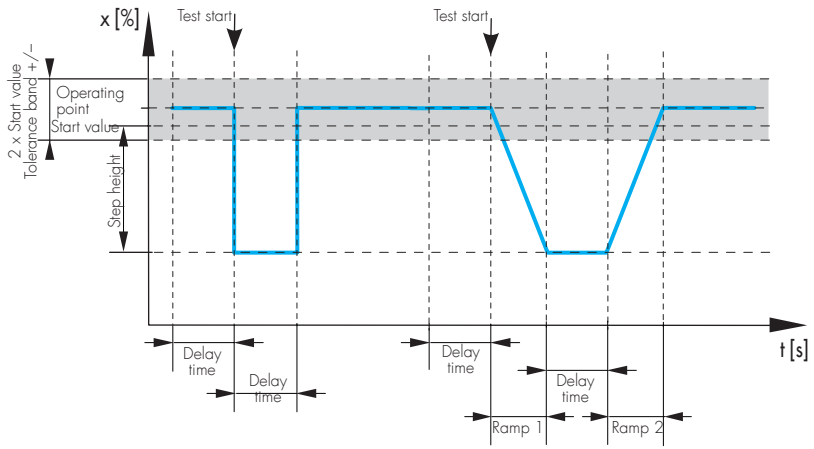


Fig. 12: *Course of the partial stroke test with step response (left) and ramp function (right)*

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

– Canceled: max. dead time (not write-enabled)
– Dead time limit determined: can only be selected in the 'Customer expert' user level

Tolerance bands

– 'Start value of tolerance band +/–': the test is not started when the operating point is outside the range: 'Start value' ± 'Start value of tolerance band +/–'.

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

– Start value of tolerance band +/–: 1 to 100 %, [3 %]

– 'Canceled: tolerance band (ramp) +/–', 'Canceled: tolerance band (step) +/–': The test is canceled as soon as the deviation of the valve position (in relation to the theoretical step end value, calculated from the 'Start value' and 'Step height') exceeds the adjusted value.

  This cancellation criterion only takes effect when 'Canceled: tolerance band (ramp) +/–' or 'Canceled: tolerance band (step) +/–' is set to ≠ 0 %.

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

– Canceled: tolerance band (step) +/–: can only be selected in the 'Customer expert' user level
– Canceled: tolerance band (ramp) +/–: 1 to 100 %, [5 %]

Valve position

– 'Canceled: x monitoring': the test is canceled when 'Minus' is selected as the 'Test direction' as soon as the valve position falls below the adjusted value. The test is canceled when 'Plus' is selected as the 'Test direction' as soon as the valve position exceeds the adjusted value.

  This cancellation criterion only takes effect when 'Canceled: x monitoring' is set to ≠ 0 %.

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

– Canceled: x monitoring: –20 to 120 %, [ATO: 85 %; ATC: 15 %]

Pressure criteria

Analysis of the pressure only possible when the positioner is fitted with the optional pressure sensors.

– 'Canceled (press. limit)': the test is canceled after the valve has moved to the test end value through venting and the pressure is below this limit. The test is canceled after the valve has moved to the test end value through supplying air and the pressure exceeds this limit.

  This cancellation criterion only takes effect when the 'Activate pressure monitoring' is set to "Active".

Tip

The minimum or maximum pressure of the reference test can be used as a guide for the limit defined in 'Canceled (press. limit)'. See Chapter 6.1.3.

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

– Activate pressure monitoring: **Active**
– Canceled (press. limit): [0.00] to 10.00 bar

Notes on cancellation criteria

– *The partial stroke test must only be performed with the cancellation conditions (time or valve position) for valves with double-acting actuator and pneumatic booster as well as for valves that have been initialized using the SUB mode.*
– *Excessive overshooting may occur in valves fitted with volume boosters. In this case, the test cancellation criteria 'Canceled: x monitoring' and 'Canceled: tolerance band (ramp) +/–' or 'Canceled: tolerance band (step) +/–' must be increased accordingly.*

The reason why the test was canceled can be read in the 'Results of last test' parameter. Besides cancellation due to the configured test cancellation criteria, further events lead to the test being canceled, for example:

– The internal forced venting function is triggered.
– The current is lower than 3.8 mA.
– The test is manually canceled:
  ➔ On site by pressing the rotary push-button
  ➔ In the software with the 'Stop test' parameter
– The positioner switches to the SAFE mode.
– At the start of the partial stroke test triggered by the binary input, the edge control changes again to the state which starts the partial stroke test.
– In AUTO mode, the edge control changes to the state in which the valve moves to a fixed value which is outside the range: 'Start value' ± 'Start value of tolerance band +/–'.

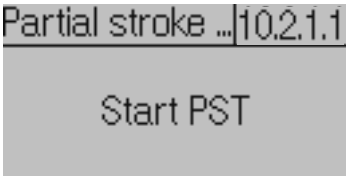
6.1.2 Test start

Table 12: *Start conditions of partial stroke test*

Operating mode	See Chapter 6.1.2.1 for manual start (on site or using software)	Automatic start after 'Test interval' has elapsed (see Chapter 6.1.2.2)	Start triggered by binary input (see Chapter 6.1.2.3)
AUTO	YES	YES	YES
MAN	YES	NO	YES

6.1.2.1 Manual start

On-site operation



➔ Use the rotary pushbutton to go to the 'Partial stroke test (PST)' command (menu item: [10 Diagnosis/maintenance > Tests]). See ▶ EB 8484-3.

➔ Press ⊛ to start test.

i ***Note***

A test can be canceled manually by pressing the rotary pushbutton again.

Software command via TROVIS-VIEW/integration

> Diagnosis/maintenance > Tests > Partial stroke test (PST)
! Start PST

i ***Note***

The test can be canceled manually by selecting the 'Stop test' command.

6.1.2.2 Automatic start after 'Test interval' has elapsed

The partial stroke test (PST) is started in AUTO mode at regular intervals after the time entered in 'Test interval' has elapsed when the function is activated. The 'Delay time interval' parameter allows the test to be postponed once.

i ***Note***

The time until the next regular test can be changed in the 'Time until next test' information parameter.

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration
– Test interval: 1 to 365 d, [7 d] – Activate test interval: [Not active], Active – Delay test interval: [0] to 2160 h

> Diagnosis/maintenance > Tests > Partial stroke test (PST)
– Time until next test (not write-enabled)

6.1.2.3 Start triggered by binary input

Function only when positioners have the optional binary input (option A or B).

> Configuration > Options
– Action upon active binary input: **start PST** – Edge control: [Active = switch closed], Active = switch open

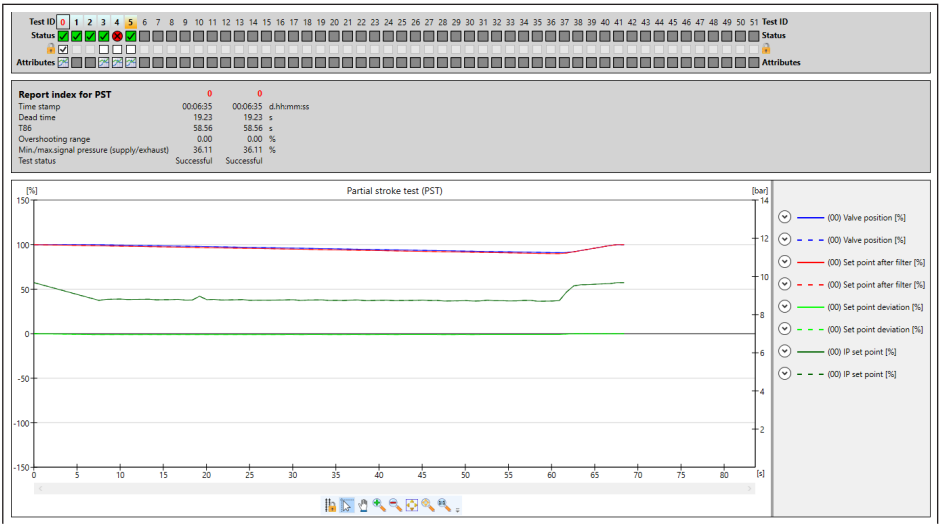


Fig. 13: > *Diagnosis/maintenance > Tests > Partial stroke test (PST) > Reports and diagrams (graph shows the partial stroke test for a positioner without pressure sensors)*

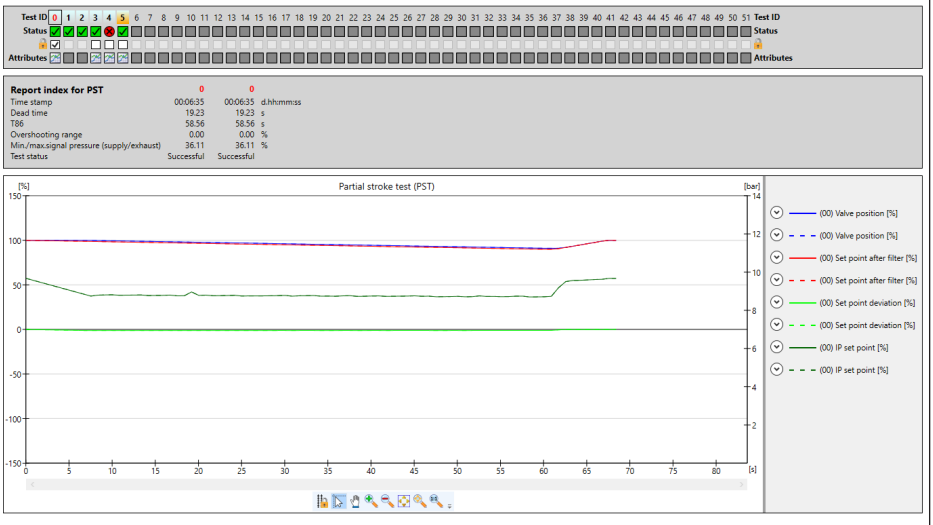


Fig. 14: > *Diagnosis/maintenance > Tests > Partial stroke test (PST) > Reports and diagrams (graph shows the partial stroke test for a positioner with pressure sensors)*

6.1.3 Analysis and monitoring

The analysis of the last fifty partial stroke tests (PST) is saved with a time stamp in the [> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Reports and diagrams] folder. The last seven graphs at the maximum are shown.

The result of the last test can be read in the [> Diagnosis/maintenance > Tests > Partial stroke test (PST)] folder.

Note

In total, seven full stroke tests (FST) with report and diagram can be displayed.

Test completed successfully

The following analysis parameters are shown after a completed partial stroke test (PST).

Two test reports can be shown at one time for comparison. The comparison test can be selected as required.

– Positioner without pressure sensors:

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Reports and diagrams

– Time stamp (not write-enabled)
– Dead time (not write-enabled)
– T86 (not write-enabled)
– Overshooting (not write-enabled)
– Min./max. manipulated variable (fill with air/venting)
– Test status (not write-enabled)

– Positioner with pressure sensors:

> Diagnosis/maintenance > Tests > Partial stroke test (PST) > Reports and diagrams

– Time stamp (not write-enabled)
– Dead time (not write-enabled)
– T86 (not write-enabled)
– Overshooting (not write-enabled)
– Min. pressure (ramp 1; exhaust)/max. pressure (ramp 1; supply)
– Breakaway pressure
– Test status (not write-enabled)

The results of the first partial stroke test performed with the current configuration are used as a reference and are write-protected. All other partial stroke tests can be write-protected manually:

➔ Check box.

Test not completed

If the test is canceled and no events have occurred that activate the fail-safe position, the positioner changes to the 'Target operating mode'.

The fail-safe position can be activated, for example when the forced venting is triggered and when the current is lower than 3.8 mA.

A test cancellation causes the 'PST: cancellation criteria met' status message to be generated with the assigned status classification.

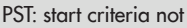
If the test cannot be started, the 'PST: start criteria not met' status message with the assigned status classification is generated.

Note

No graph is plotted when a test cannot be started.

> Diagnosis/maintenance > Configuration > Status classification

– PST: cancellation criteria met:

– PST: start criteria not met:


> Diagnosis/maintenance > Device state > Status messages

– PST: cancellation criteria met
– PST: start criteria not met

➔ Recommended action when the test is canceled (see Table 13)

Statistical analysis

Every time a partial stroke test is started, one of the following counters counts this event depending on the test status.

> Diagnosis/maintenance > Tests > Partial stroke test (PST)

– Number of successful tests (not write-enabled)
– Number of canceled tests (not write-enabled)
– Number of failed start criteria (not write-enabled)

6.1.4 Reset

➔ See Table 14

Table 13: *Recommended action when the status message is generated*

	Test result	**SAMSON recommends:**
PST: cancellation criteria met	Current	➔ Check input signal
	Internal error	➔ Restart test
	Timeout	➔ Check seat and plug for deposits or foreign particles
	No movement possible	
PST: start criteria not met	Start criteria	➔ Check test configuration
	Function active	➔ Wait for the active test to finish and restart test.
	Incorrect operating mode	➔ Set operating mode corresponding to Table 12 and restart test.

Table 14: *Resetting the partial stroke test (PST)*

	'Reset diagnosis'	'Clear reports'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset configuration	NO	NO	YES	YES	NO	NO
Reset reports	YES	YES	YES	YES	NO	NO
Reset histograms	YES	YES	YES	YES	NO	NO
Reset reference test	YES	NO	YES	YES	NO	NO
Reset status messages	YES	NO	YES	YES	NO	NO

6.2 Full stroke test (FST)

The dynamic control response can be evaluated by performing the test. During the full stroke test (FST), the valve moves through its entire working range.

The valve can move through the working range either in steps or with a ramp function (Fig. 15). The test is performed with the ramp function when the ramp time ('Ramp') is set to ≠ 0 s.

The test starts after the 'Delay time' has elapsed. This ensures that the valve has reached the open position.

Starting from the open position, the valve moves to the closed position. The valve remains in this position for the time defined by the 'Waiting time' before performing a second step change in the opposite direction from the closed position to the open position.

The 'Sampling time' defines the time interval between which the measured values are recorded during the test.

> Diagnosis/maintenance > Tests > Full stroke test (FST) > Configuration

– Ramp 1: 0 to 9999 s, [60 s]
– Waiting time: can only be selected in the 'Customer expert' user level

6.2.1 Test cancellation criteria

The positioner cancels the full stroke test (FST) when one of the following cancellation conditions is fulfilled:

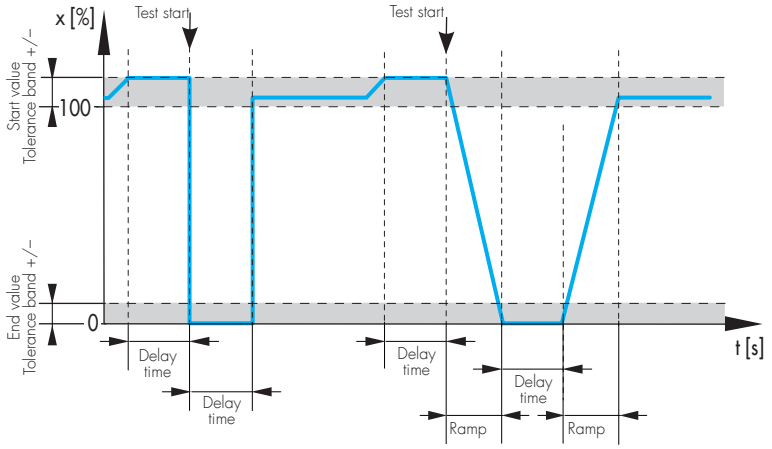


Fig. 15: *Course of the full stroke test with step response (left) and ramp function (right)*

Time

– 'Canceled: max. test duration': the test is canceled when the maximum permissible test duration is reached.

> **> Diagnosis/maintenance > Tests > Full stroke test (FST) > Configuration**
>
> – Canceled: max. test duration (not write-enabled)

Tolerance bands

– 'Start value of tolerance band +/–': the test is not started when the operating point is outside the range: open position – 'Start value of tolerance band'.

> **> Diagnosis/maintenance > Tests > Full stroke test (FST) > Configuration**
>
> – Start value of tolerance band +/–: 1 to 100 %, [3 %]

– 'End value of tolerance band +/–': the test is not started when the valve position after the first step does not reach the range: closed position + 'End value of tolerance band +/–'.

> **> Diagnosis/maintenance > Tests > Full stroke test (FST) > Configuration**
>
> – End value of tolerance band +/–: 1 to 100 %, [3 %]

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

– The internal forced venting function is triggered.

– The current is lower than 3.8 mA.

– The test is manually canceled:

  ➔ On site by pressing the rotary push-button

  ➔ In the software with the 'Stop test' parameter

– The positioner switches to the SAFE mode.

– At the start of the full stroke test triggered by the binary input, the edge control changes again to the state which starts the full stroke test (FST).

6.2.2 Test start

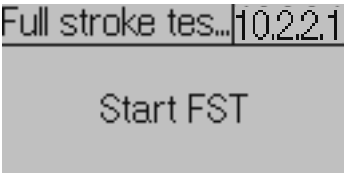
Table 15: *Start conditions of full stroke test (FST)*

Operating mode	See Chapter 6.2.2.1 for manual start (on site or using software)	Start triggered by binary input (see Chapter 6.2.2.2)
AUTO	NO [1]	NO [1]
MAN	YES	YES

[1] Default setting
By activating the 'Allow start in AUTO mode' parameter in the 'Customer expert' user level, the test can also be started in AUTO mode.

6.2.2.1 Manual start

On-site operation



➔ Use the rotary pushbutton to go to the 'Full stroke test (FST)' command (menu item: [10 Diagnosis/maintenance > Tests]). See ▶ EB 8484-3.

➔ Press ⊛ to start test.

i Note

A test can be canceled manually by pressing the rotary pushbutton again.

Software command via TROVIS-VIEW/integration

> Diagnosis/maintenance > Tests > Full stroke test (FST)

! Start test

i Note

The test can be canceled manually by selecting the 'Stop test' command.

6.2.2.2 Start triggered by binary input

Function only when positioners have the optional binary input (option A or B).

> Configuration > Options

– Action upon active binary input: **start FST**
– Edge control: [Active = switch closed], Active = switch open

6.2.3 Analysis and monitoring

The analysis of the last six full stroke tests (FST) at the maximum and graphs are saved with a time stamp in the [> Diagnosis/maintenance > Tests > Full stroke test (FST) > Reports and diagrams] folder.

The result of the last test can be read in the [> Diagnosis/maintenance > Tests > Full stroke test (FST)] folder.

i Note

In total, seven stroke tests (PST plus FST) with report and diagram can be displayed.

Test completed successfully

The following analysis parameters are shown after a completed full stroke test (FST).

Two test reports can be shown at one time for comparison. The comparison test can be selected as required.

– *Positioner without pressure sensors:*

> Diagnosis/maintenance > Tests > Full stroke test (FST) > Reports and diagrams

– Time stamp (not write-enabled)
– Dead time (rising) (not write-enabled)
– Dead time (falling) (not write-enabled)
– T86 (rising) (not write-enabled)
– T86 (falling) (not write-enabled)
– T98 (rising) (not write-enabled)
– T98 (falling) (not write-enabled)
– Test status (not write-enabled)

Fig. 16: *> Diagnosis/maintenance > Tests > Full stroke test (FST) > Reports and diagrams (graph shows the partial stroke test for a positioner without pressure sensors)*

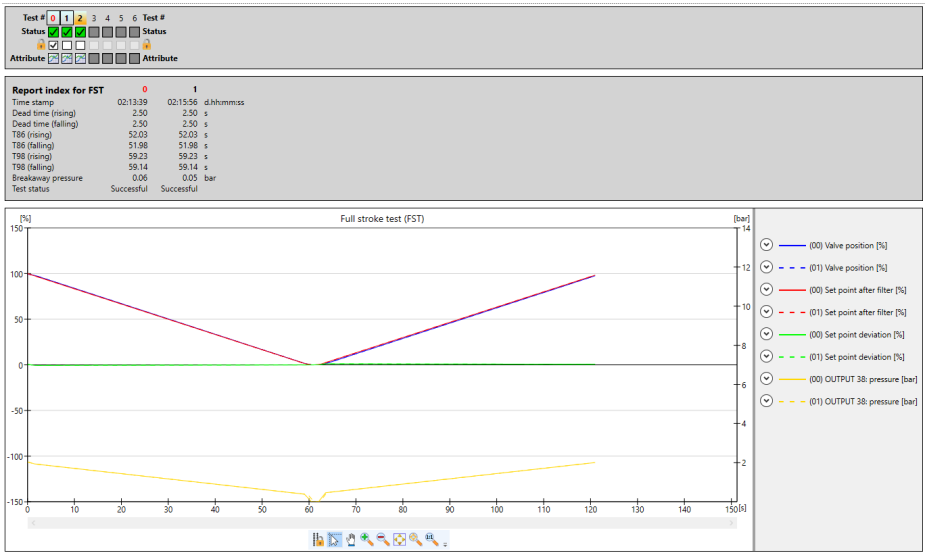


Fig. 17: *> Diagnosis/maintenance > Tests > Full stroke test (FST) > Reports and diagrams (graph shows the partial stroke test for a positioner with pressure sensors)*

– Positioner with pressure sensors:

> Diagnosis/maintenance > Tests > Full stroke test (FST) > Reports and diagrams

– Time stamp (not write-enabled)
– Dead time (rising) (not write-enabled)
– Dead time (falling) (not write-enabled)
– T86 (rising) (not write-enabled)
– T86 (falling) (not write-enabled)
– T98 (rising) (not write-enabled)
– T98 (falling) (not write-enabled)
– Breakaway pressure
– Test status (not write-enabled)

The results of the first full stroke test (FST) performed with the current configuration are used as a reference test and are write-protected. All other full stroke tests can be write-protected manually:

➔ Check  box.

Test not completed

If the test is canceled and no events have occurred that activate the fail-safe position, the positioner changes to the 'Target operating mode'.

The fail-safe position is activated when the forced venting is triggered and when the current is lower than 3.8 mA.

A test cancellation causes the 'FST: cancellation criteria met' status message to be generated with the assigned status classification.

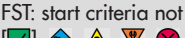
If the test cannot be started, the 'FST: start criteria not met' status message with the assigned status classification is generated.

Note

No graph is plotted when a test cannot be started.

> Diagnosis/maintenance > Configuration > Status classification

– FST: cancellation criteria met:

– FST: start criteria not met:


> Diagnosis/maintenance > Device state > Status messages

– FST: cancellation criteria met
– FST: start criteria not met

➔ Recommended action when the test is canceled (see Table 16)

Statistical analysis

Every time a full stroke test is started, one of the following counters counts this event depending on the test status.

> Diagnosis/maintenance > Tests > Full stroke test (FST)

– Number of successful tests (not write-enabled)
– Number of canceled tests (not write-enabled)
– Number of failed start criteria (not write-enabled)

6.2.4 Reset

➔ See Table 17

Table 16: *Recommended action when the status message is generated*

	Test result	**SAMSON recommends:**
FST: cancellation criteria met	Current	➔ Check input signal
	Internal error	➔ Restart test
	Timeout	➔ Check seat and plug for deposits or foreign particles
	No movement possible	
FST: start criteria not met	Start criteria	➔ Check test configuration
	Function active	➔ Wait for the active test to finish and restart test.
	Incorrect operating mode	➔ Set operating mode corresponding to Table 15 and restart test.

Table 17: *Resetting the full stroke test*

	'Reset diagnosis'	'Clear reports'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset configuration	NO	NO	YES	YES	NO	NO
Reset reports	YES	YES	YES	YES	NO	NO
Reset histograms	YES	YES	YES	YES	NO	NO
Reset reference test	YES	YES	YES	YES	NO	NO
Reset status messages	YES	NO	YES	YES	NO	NO

6.3 Dead band

The difference in *set point w* that causes a minimal change in the *valve position x* is termed 'dead band'.

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

The test is started in the manual mode.

During the dead band test, the positioner moves the valve in small steps through the range of 'Start set point' ±½ 'Span'. After every step the positioner records the response of the *valve position x*.

The test starts at the 'Start set point' and ends at position 1.

– 'Start set point' – ½ 'Span' in 'Start direction' = 'Minus' or
– 'Start set point' + ½ 'Span' in 'Start direction' = 'Plus'

After the 'Delay time after set point change' elapses, the valve moves from position 1 to position 2:

– 'Start set point' + ½ 'Span' in 'Start direction' = 'Minus' or
– 'Start set point' – ½ 'Span' in 'Start direction' = 'Plus'

After the 'Delay time after set point change' elapses, the positioner defines a further set point change, which starts in position 2 and ends at the 'Start set point'.

6.3.1 Analysis and monitoring

The dead band test provides statements on the minimum, maximum and average dead band:

– 'Min. dead band': minimum change in the set point that causes a minimal change in the valve position.
– 'Max. dead band': maximum change in the set point that causes a minimal change in the valve position.
– 'Average dead band': average change in the set point that causes a minimal change in the valve position.

A plotted diagram is generated after the test is successfully completed. Two different types of diagrams are available:

– DIN: valve position [%] plotted against the set point after filter [%]
– ISA: valve position [%] and the set point after filter [%] plotted over time [s]

Defining parameters

1. Switch to MAN mode.
2. Select test parameters.
3. Start test.
   The 'Test status' generates an 'Active' message.
   'Function check' is activated as the condensed state.

	> TROVIS 3730-3
1.	– Target operating mode: MAN

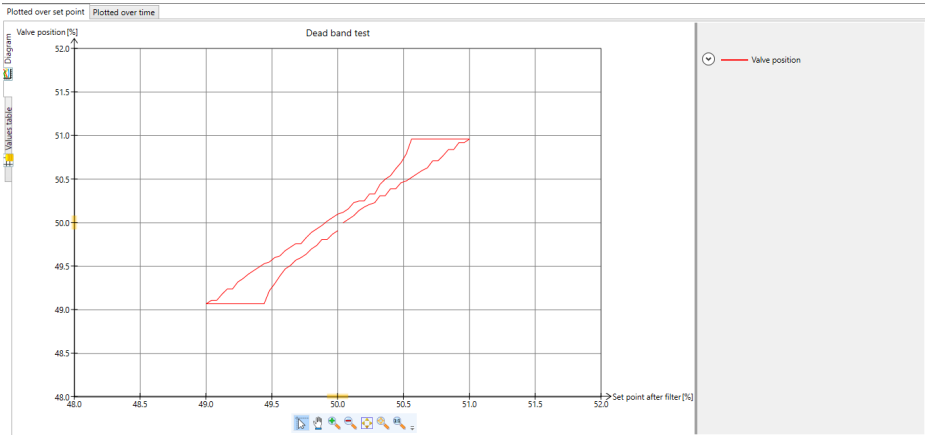


Fig. 18: *> Diagnosis/maintenance > Tests > Dead band > Reports and diagrams > Plotted over set point*

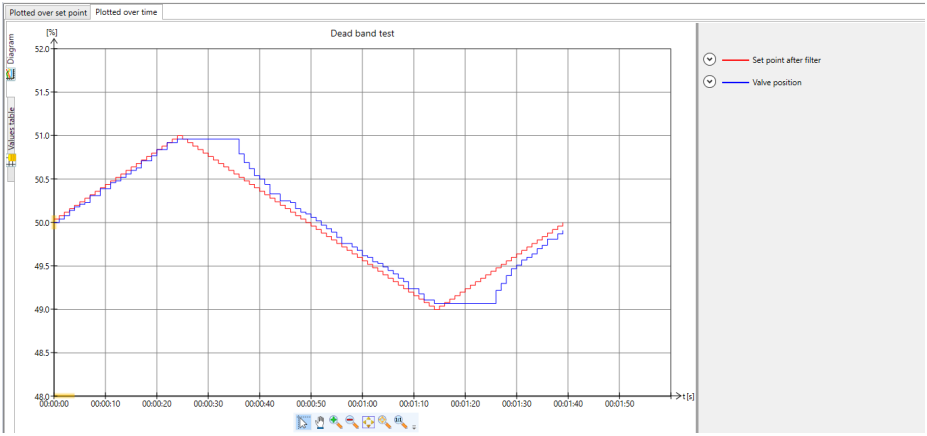


Fig. 19: *> Diagnosis/maintenance > Tests > Dead band > Reports and diagrams > Plotted over time*

> Diagnosis/maintenance > Tests > Dead band
2. – Start set point: 0.0 to 100.0 %, [50.0 %] – Start direction: Minus, [Plus] – Span: 1 to 50 %, [1 %] – Delay time after set point change: 0.2 to 25.0 s, [1.0 s]
3. – Start test

Note

Cancel the test by right-clicking 'Stop test' and selecting 'Execute' or by pressing the rotary pushbutton on the positioner. After the test has been canceled, the positioner remains in manual mode.

6.3.2 Reset

See Table 18

Table 18: *Resetting the dead band test*

	'Reset diagnosis'	'Reset dead band test'	'Reset (standard)'	'Reset (advanced)'	Restart	Reset initialization
Reset measured data and diagram	YES	YES	YES	YES	NO	NO

6.4 Valve signature (test without pressure sensors)

To assess the valve, the valve signature IP can be recorded again in a repetition test and compared with an already recorded reference (see Chapter 5.4).

The repetition test is performed in the same way as the plotting of the reference graph described in Chapter 5.4.1: The valve is moved from the unpressurized end position until it is close to the maximum open position and back again. To perform this function, the pneumatic unit switches to open-loop control (control without feedback).

After the valve signature has been plotted, the mean values for exhaust, supply and the valve position are converted into fixed points (see Fig. 20).

Defining parameters

1. Switch to MAN mode.
2. Start test.
   The 'Test status' generates an 'Active' message.
   'Function check' is activated as the condensed state.

	TROVIS 3730-3
1.	– Target operating mode: MAN

	> Diagnosis/maintenance > Tests > Valve signature
2.	! Start repetition test

Note

Cancel the test by right-clicking 'Stop test' and selecting 'Execute' or by pressing the rotary pushbutton on the positioner. After the test has been canceled, the positioner remains in manual mode.

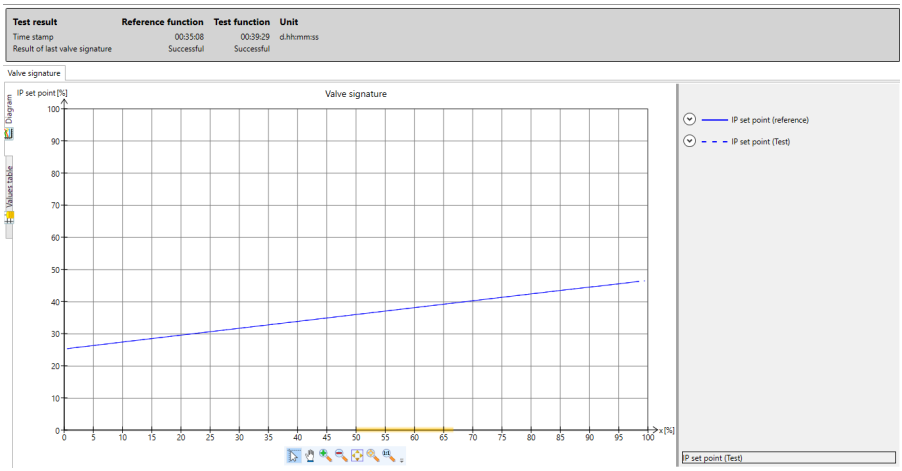


Fig. 20: *> Diagnosis/maintenance > Tests > Valve signature > Reports and diagrams*

6.4.1 Analysis and monitoring

A plotted diagram is generated in the [> Diagnosis/maintenance > Tests > Valve signature > Reports and diagrams] after the test is successfully completed.

The test report of the reference (initialization) and the report of the last repetition test (Test) are shown at the same time for comparison purposes.

The test values are lower than those of the reference test. Both lines start to rise slightly at the same time. This points to a reduced spring force in the actuator. The cause may be a broken actuator spring, reduced stiffness of the actuator springs or a reduced signal pressure due to air leakage within the actuator. In such cases, the 'Broken spring detected' status message is generated.

> Diagnosis/maintenance > Configuration > Status classification

– Broken spring detected: ☑, [◈], ⚠, ▽, ⊗
– Pneumatic leakage: [Highest classification]

> Diagnosis/maintenance > Device state > Status messages

– Broken spring detected
– Pneumatic leakage

➔ SAMSON recommends checking the actuator springs when the status message is generated.

6.4.2 Reset

➔ See Table 19

Table 19:
Resetting the valve signature (test)

	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Reset initialization
Reset configuration	NO	YES	YES	NO
Reset reports	YES	YES	YES	NO
Reset measured data and diagram	YES	YES	YES	NO

6.5 Valve signature (test with pressure sensors)

To assess the valve, the valve signature can be recorded again in a repetition test and compared with an already recorded reference (see Chapter 6.4).

The repetition test is performed in the same way as the plotting of the reference graph described in Chapter 5.5.1: The valve is moved from the unpressurized end position until it is close to the maximum open position and back again. To perform this function, the pneumatic unit switches to open-loop control (control without feedback).

After the valve signature has been plotted, the recorded values for 'Pressure (supply)', 'Pressure (exhaust)' and the valve position are converted into fixed points.

Defining parameters

1. Switch to MAN mode.
2. Start test.
   The 'Test status' generates an 'Active' message.
   'Function check' is activated as the condensed state.

	TROVIS 3730-3
1.	– Target operating mode: MAN

	> Diagnosis/maintenance > Tests > Valve signature
2.	! Start repetition test

Note

Cancel the test by right-clicking 'Stop test' and selecting 'Execute' or by pressing the rotary pushbutton on the positioner. After the test has been canceled, the positioner remains in manual mode.

6.5.1 Analysis and monitoring

A plotted diagram is generated in the [> Diagnosis/maintenance > Tests > Valve signature > Reports and diagrams] after the test is successfully completed.

The test report of the reference (initialization) and the report of the last repetition test (Test) can be shown at the same time for comparison purposes.

The test values are lower than those of the reference test. Both lines start to rise slightly at the same time. This points to a reduced spring force in the actuator. The cause may be a broken actuator spring, reduced stiffness of the actuator springs or a reduced signal pressure due to air leakage within the actuator. In such cases, the 'Broken spring detected' status message is generated.

> Diagnosis/maintenance > Configuration > Status classification
– Broken spring detected: [Highest classification] – Pneumatic leakage: [Highest classification]

> Diagnosis/maintenance > Device state > Status messages
– Broken spring detected – Pneumatic leakage

➔ SAMSON recommends checking the actuator springs when the status message is generated.

6.5.2 Reset

➔ See Table 20

Table 20: *Resetting the valve signature (test)*	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'	Reset initialization
Reset configuration	NO	YES	YES	NO
Reset reports	YES	YES	YES	NO
Reset measured data and diagram	YES	YES	YES	NO

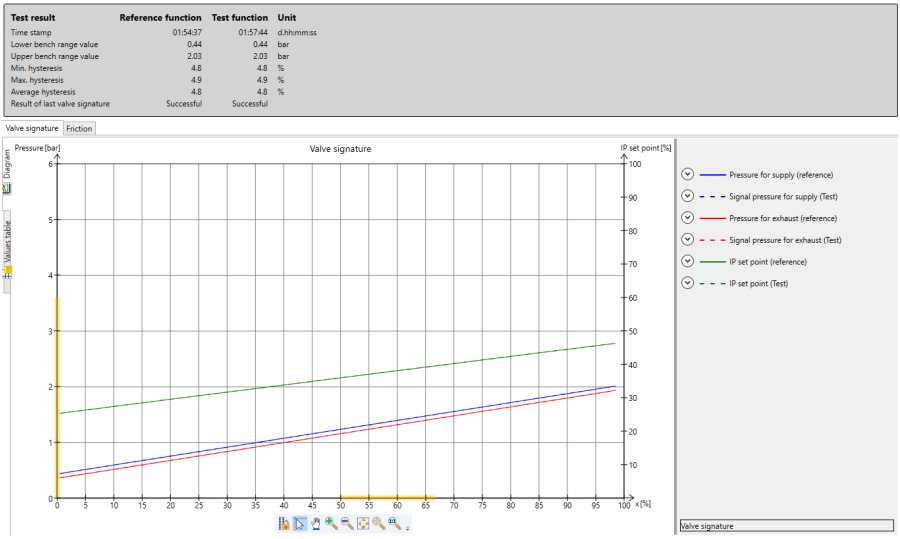


Fig. 21: > *Diagnosis/maintenance > Tests > Valve signature > Reports and diagrams*

7 Error messages and recommended corrective action

Message	Recommended action	Possible status classification
> Diagnosis/maintenance > Configuration > Status classification		
Control valve diagnosis		
No supply pressure [1)]	(see Chapter 5.5.2) ➔ Check air supply. ➔ Check air lines/connections. **Note:** Message only for positioners with pressure sensors.	YES [⚠]
Low supply pressure [1)]	(see Chapter 5.5.2) ➔ Check air supply. ➔ Check air lines/connections. **Note:** Message only for positioners with pressure sensors.	YES [◆]
Supply pressure >7 bar [1)]	(see Chapter 5.5.2) ➔ Check air supply. ➔ Check supply pressure regulator. **Note:** Message only for positioners with pressure sensors.	YES [?]
Friction change (open pos.) [1)]	(see Chapter 5.5.3) ➔ Check the valve's packing. **Note:** Message only for positioners with pressure sensors.	YES [☑]
Friction change (mid-pos.) [1)]	(see Chapter 5.5.3) ➔ Check the valve's packing. **Note:** Message only for positioners with pressure sensors.	YES [☑]
Friction change (closed pos.) [1)]	(see Chapter 5.5.3) ➔ Check the valve's packing. **Note:** Message only for positioners with pressure sensors.	YES [☑]
Valve signature failed [1)]	(see Chapter 6.5) **Note:** Message only for positioners with pressure sensors.	YES [◆]
Spring possibly broken	See Chapter 5.4.2 and Chapter 5.5.2. ➔ Perform the valve signature test to verify the result. ➔ If the result is verified, check the actuator springs.	YES [◆]

Message	Recommended action	Possible status classification
Broken spring detected	See Chapter 6.4 and Chapter 6.5. ➔ Check actuator springs.	YES [◈]
Pneumatic leakage	See Chapter 5.4.2 and Chapter 5.5.2. ➔ Check that pneumatic installations and connections are tight.	YES [◈]
PST: start criteria not met	(see Chapter 6.1)	YES [☑]
PST: cancellation criteria met	(see Chapter 6.1)	YES [◈]
FST: start criteria not met	(see Chapter)	YES [☑]
FST: cancellation criteria met	(see Chapter)	YES [◈]
AMR signal outside range	➔ Check attachment.	YES [◈]
Hardware fault	➔ Confirm error and select AUTO operating mode. ➔ Re-initialize positioner.	YES [Highest classification]
Limit for total valve travel exceeded	➔ Check valve and attachment for signs of wear.	YES [◈]
Lower end position shifted	(see Chapter 5.2)	YES [◈]
Upper end position shifted	(see Chapter 5.2)	YES [◈]
Dynamic stress factor exceeded	(see Chapter 5.1.4)	YES [◈]
Set point deviation	➔ Check attachment. ➔ Check air supply. ➔ Check air lines/connections.	YES [◈]
Brownout	➔ Check input signal.	YES [◈]
Current too low (w < 3.7 mA)	➔ Check input signal.	YES [⚠]
Fail-safe position (w <3.85 mA)	➔ Check input signal.	YES [⚠]
Current too high (w >22 mA)	➔ Check input signal.	YES [⚠]
Angle limitation	➔ Check attachment.	YES [Highest classification]
Temperature inside device below min. limit	➔ Check operating conditions.	YES [⚠]
Temperature inside device above max. limit	➔ Check operating conditions.	YES [⚠]

Message	Recommended action	Possible status classification
Logging suspended	The positioner's functioning is not impaired. The message no longer appears after the positioner starts logging again.	YES [◈]
Operating range in CLOSED position	➔ Check attachment. ➔ Check whether another valve can be used.	YES [☑]
Operating range in max. OPEN position	➔ Check attachment. ➔ Check whether another valve can be used.	YES [☑]
Operating range shifting towards CLOSED position	➔ Rethink the working range.	YES [☑]
Operating range shifting towards max. OPEN position	➔ Rethink the working range.	YES [☑]
Limited working range: lower range	➔ Check that pneumatic installations and connections are tight. ➔ Check supply pressure. ➔ Check plug stem for external influences that could be blocking it.	YES [☑]
Limited working range: upper range	➔ Check that pneumatic installations and connections are tight. ➔ Check supply pressure. ➔ Check plug stem for external influences that could be blocking it.	YES [☑]

1) Reading only if the positioner has pressure sensors (see nameplate of the positioner).

EB 8389-3 EN

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