



EB 8389-2 EN

Translation of original instructions

Diagnosis / maintenance ▶ Device state ▶ Status messages					
Name			Value	Unit	Comment
Diagnosis					Maintenance required
Friction change (open pos.)		✓		No	
Friction change (mid-pos.)		✓		No	
Friction change (closed pos.)		✓		No	
Valve sign. failed		✓		No	
No supply press.		✓		No	
Low supply pressure		✓		No	
Supply pressure > 10 bar		✓		No	
PST		✓			No message
PST: cancellation criteria met		✓		No	
PST: start criteria not met		✓		No	
FST		✓			No message
FST canc. crit. met		✓		No	
FST: start criteria not met		✓		No	
Pneumatic module A (P3799 A)		✓			No message
P3799: failure		✓		No	
P3799: movement impaired		✓		No	
P3799: maintenance required		✓		No	
P3799: initialization error		✓		No	
Pneumatic module B (P3799 B)		✓			No message
P3799: failure		✓		No	
P3799: movement impaired		✓		No	
P3799: maintenance required		✓		No	
P3799: initialization error		✓		No	
AMR signal outside range		✓		No	
Hardware error		✓		No	
Limit for total valve travel exceeded		✓		No	
Lower end position shifted		✓		No	

EXPERTplus Valve Diagnostics

TROVIS 3793 Electropneumatic Positioner

Firmware version 1.01.xx

Edition March 2023



Documents relating to the device, such as the mounting and operating instructions, are available on our website at www.samsunggroup.com > *Service & Support > 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

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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 for the direct handling of the valve diagnostics integrated into the positioner. Work on the control valve may be necessary when mounting or removing the device.

- Observe the requirements for personal protective equipment specified in the valve documentation.
- Check with the plant operator for details on further protective equipment.

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 instructions and measures

Safety features

Diagnostic settings can be performed on site at the positioner or using the TROVIS-VIEW software or DD, DTM and EDD.

The TROVIS-VIEW software only has a direct influence on the connected positioner while data are being exchanged between the software and positioner (online mode).

Warning against residual hazards

Diagnostic settings, which can be performed on site at the positioner or, when the data connection is active, using the TROVIS-VIEW software or DD, DTM and EDD, have a direct influence on the control 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, warning 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 documentation

The following documents apply in addition to these operating instructions:

- Mounting and operating instructions (EB) and configuration manual (KH) for mounted device:
 - ▶ EB 8493 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.

Manipulation of the configuration due to unauthorized access.

The positioner can be protected against unauthorized access through the use of a customized password. The password can be activated and changed in the software.

- Do not pass the password on to unauthorized persons. Keep it in a safe place inaccessible to unauthorized persons.

2 Operation

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

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. Software download
▶ www.samsongroup.com > SERVICE & SUPPORT > Downloads > TROVIS-VIEW
- **DTM** · Device type manager to describe the device and communication properties. Integration file
▶ www.samsongroup.com > SERVICE & SUPPORT > Downloads > Device integration
- **EDD** · Electronic Device Description. Integration file ▶ www.samsongroup.com > SERVICE & SUPPORT > Downloads > Device integration

Note

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

2.1.1 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.
- Descriptions that apply to the 'Customer expert' user level are marked.
 - Contact SAMSON's After-sales Service to obtain access to the 'Customer expert' 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:



2.2 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 3793 Positioner (► EB 8493) for a list of all parameters that can be changed locally at the positioner.

A password can be activated to prevent on-site access to the positioner settings without prior consent. After the password has been activated, the positioner settings can only be changed on site after entering the password at the positioner.

i Note

We recommend:

- Changing the password before first use.
 - Keeping the password in a safe place inaccessible to unauthorized persons.
 - Only passing on the password to authorized persons.
-

TROVIS 3793 > Configuration

- Activate password: [Not active], Active
 - Modify password: 0000 to 9999, [1234]
-

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. Check and compare the options installed in the positioner with the software.

Various options can be installed or retrofitted in the TROVIS 3793 Positioner (see the Mounting and Operating Instructions ► EB 8493).

 - ➔ Check the parameter settings and status of the options (see Table 1).
3. Put the positioner into operation as described in the Mounting and Operating Instructions ► EB 8493.

We recommend using the following settings:

- Positioners with pneumatic module combination P3799-0001 and P3799-0000 or pneumatic module combination P3799-0003 and

Start-up

P3799-004: the air output capacity of the software restriction is automatically adapted to the actuator size when the 'Automatic software restriction setting' function is activated.

TROVIS 3793 > Start-up

– Automatic software restriction setting: [Active]

- Initialization with valve signature ensures that the full diagnostic functions are available when the positioner is fitted with pressure sensors.


























TROVIS 3793 > Start-up









































– Init. with valve signature: [Yes]

When initialization fails, the positioner generates a status message with the assigned status classification. See section 5.

If a status message is generated during initialization, the group status 'Start-up' and 'Initialization' are also generated with the assigned status classification. See section 5.

TROVIS 3793 > 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:     

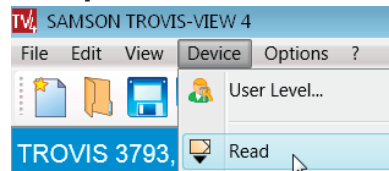
- Init: pin position:     
- Init: no movement:     
- Init: canceled (control accuracy):      [highest classification]
- Init: low control accuracy:      [highest classification]
- Positioner not initialized:     
- Init: canceled externally:     
- Init: angle limitation:      [highest classification]
- Init: timeout:      [highest classification]

TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

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

4. 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 'Pressure sensors' option is installed in the positioner (see nameplate and Table 1).

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 3793 > Start-up

- Pressure limit: 2.5 to 10 bar [7.0 bar]

TROVIS 3793 > Configuration > Set point processing

- Lower end position: **[Active]**

Table 1: Required parameter settings for options and modules

Options and modules	Parameter settings for full functionality	Comments
Pressure sensors	TROVIS 3793 > Configuration > Slot options > Pressure sensors – Pressure sensors exist: Yes	The pressure sensors option is necessary to use the following diagnostic functions: <ul style="list-style-type: none"> – Signal pressure limitation (see section 3.1) – Course of supply pressure (see section 6.2) – Valve signature (see section 6.4)

Options and modules	Parameter settings for full functionality	Comments
Module with software switches NAMUR (Z3799 Module [N])		
Module with hardware inductive switches NAMUR (Z3799 Module [P]) ²⁾		
Module with hardware switches SPDT (Z3799 Module [M]) ²⁾		
Ext. position sensor (ohm) (Z3799 Module [E]) ^{1) 2)}	TROVIS 3793 > Configuration > Slots options	
Deactivation module (Z3799 Module [V])	– Status Z3799 C/D: module active	
Analog feedback module (Z3799 Module [T])	– Identification: see 'Options and modules' column	
Module with binary input and leakage sensor (Z3799 Module [L])	1) Additionally: TROVIS 3793 > Configuration > Slots options – External position sensor status: Option active	The module with binary input and leakage sensor is necessary to use the leakage sensor diagnostic function (see section 6.5).
Binary input and output (Z3799 module [U])		
Analog input 4 to 20 mA (Z3799 Module [A])	2) The option module can only be installed in Slot D.	
Deactivation module and limit switches (Z3799 Module [F]) ²⁾		
Ext. position sensor mA (Z3799 Module [Y]) ^{1) 2)}		
Module with software limit switches PLC no Ex. (Z3799 Module [X])		
Pneumatic module A/B	TROVIS 3793 > Configuration > Pneumatic modules – P3799 A/B: Status: module active – Identification: Double-acting, Single-acting OUTPUT 138, Single-acting OUTPUT 238, Fail-in-place module	

4 Configuration

4.1 Limits

The limits for the generation of status messages can be configured in the [Configuration] folder.

Pressure sensors

Limit only displayed when the positioner is fitted with the optional pressure sensors (see Table 1):

- 'Lower press. limit'
The 'Low supply pressure' status message is generated with the assigned status classification when the supply pressure falls below the lower pressure limit.

TROVIS 3793 > Diagnosis/maintenance > Configuration

- Lower press. limit: 0.01 to 10.00 bar, [2.50 bar]*

* The 'Lower press. limit' parameter is automatically recalculated on plotting the valve signature.

Stress factor

The stress factor range is directly linked to the load cycle histogram. See section 6.1.4.

Total valve travel

- 'Total valve travel limit'
The 'Total valve travel' status message is generated when the total valve travel exceeds the limit.

TROVIS 3793 > Diagnosis/maintenance > Configuration

- 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 criterion to generate 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.
- '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 entered in this parameter.

TROVIS 3793 > Diagnosis/maintenance > Configuration

- Tolerance band for set point deviation +/-:
0.1 to 10.0 %, [5.0 %]

Logging

- 'Log all classifications'
When 'Yes' is selected, messages with 'No message' classification are also logged.






TROVIS 3793 > Diagnosis/maintenance > Configuration

- Log all classifications:
[Yes], No

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.

The following classifications are possible:

- Status classification from low to high
-  **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 section 5.2.1). 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' 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.

Any generated error messages in positioners with a binary output configured as a fault alarm output are assigned the 'Failure' status. In addition, error messages generated over the fault alarm output can also be configured to appear with the condensed state 'Function check' and/or 'Maintenance required' and 'Out of specification'. In this case, the corresponding parameters must be set (see Annex A (configuration instructions)).

Note

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

4.2.1 Reset

	Initialization	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset status classification	No	No	No	YES

Diagnosis/maintenance > Configuration

Name	Value	Unit	Code	Comment
Configuration				
Status classification				
Stress factor				
Stem seal	Not selected			
Total valve travel				
Total valve travel limit	1000	*1000	12.1.20	
Set point deviation				
Lag time for set point deviation	---	s	12.1.30	
Tolerance band for set point deviatio... [Max.CDw]	5.0	%	12.1.31	
Logging				
Log all classifications	Yes			

Fig. 1: > Diagnosis/maintenance > Configuration

5 Device state

5.1 Information parameters

The [Device state] folder contains information parameters on the positioner state.

Pressure sensors

Information parameters only displayed when the positioner is fitted with the optional pressure sensors (see Table 1):

- 'OUTPUT 138: pressure':
current pressure at output 138
- 'OUTPUT 238: pressure':
current pressure at output 238
- '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

Stress factor

The stress factor range is directly linked to the load cycle histogram. See section 6.1.4.

Total valve travel

- 'Total valve travel':
Totalled full valve travel cycle

Temperature

- See section 5.4 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). Data can be saved manually by the 'Save diagnostic data' command.

5.1.1 Reset

	Initialization	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset information parameters without operating hours counter	YES	NO	YES	YES
Reset operating hours counter	NO	NO	NO	NO
Reset limits	¹⁾	YES	YES	YES

¹⁾ Reset depending on limit


Diagnosis/maintenance ▶ Device state ▶			
Name		Value	Unit Code
[-] Device state			
[+] Status messages			12.3.2
[+] Logging			
[-] Stress factor			
[+] Dynamic stress factor		---	%
[-] Total valve travel			
[+] Total valve travel		---	12.3.40
[-] Temperature			
[+] Temperature			
[-] Time			
[+] Operating hours counter		---	d.hh:mm:ss 12.3.60
[+] Device switched on since last initialization		---	d.hh:mm:ss
[+] Device in closed-loop operation		---	d.hh:mm:ss
[+] Device in closed-loop operation since last initiali...		---	d.hh:mm:ss
[-] Counter			
[+] Number of initializations		---	12.3.65
[+] Number of zero calibrations		---	12.3.66
[-] Save			
[!] Diagnostic data			

Fig. 2: > Diagnosis/maintenance > Device state

5.2 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.

→ We recommend following the recommended action listed in section 8 when a status message occurs.

5.2.1 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 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.

5.3 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.

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

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.

Tip

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

Meldungen pro Seite 50

ID	Ereignis	Vorgang	Zeitpunkt	Vergangene Zeit
001	Regler nicht initialisiert	NAMUR-Meldung gesetzt	00:08:19	00:00:45
002	Verblockmodul geschaltet	NAMUR-Meldung aufgehoben	00:08:19	00:00:45
003	Betriebsart ungleich AUTO	NAMUR-Meldung gesetzt	00:08:19	00:00:45
004	Verblockmodul geschaltet	NAMUR-Meldung gesetzt	00:08:19	00:00:45
005	Gerätestart	Aktion gestartet	00:08:19	00:00:45
006	Regler nicht initialisiert	NAMUR-Meldung gesetzt	00:08:11	00:00:53
007	Verblockmodul geschaltet	NAMUR-Meldung aufgehoben	00:08:11	00:00:53
008	Betriebsart ungleich AUTO	NAMUR-Meldung gesetzt	00:08:11	00:00:53
009	Verblockmodul geschaltet	NAMUR-Meldung gesetzt	00:08:11	00:00:53
010	Verblockmodul geschaltet	NAMUR-Meldung aufgehoben	00:08:11	00:00:53
011	Verblockmodul geschaltet	NAMUR-Meldung gesetzt	00:08:11	00:00:53
012	Meldemodul Software NAMUR (Z3799 Module [N])	Optionsmodul aktiv	00:08:11	00:00:53
013	Binär- und Leckagemodul (Z3799 Module [L])	Optionsmodul aktiv	00:08:11	00:00:53
014	Gerätestart	Aktion gestartet	00:08:11	00:00:53
015	Binär- und Leckagemodul (Z3799 Module [L])	Optionsmodul erkannt	00:07:49	00:01:15
016	Regler nicht initialisiert	NAMUR-Meldung gesetzt	00:07:01	00:02:03
017	Verblockmodul geschaltet	NAMUR-Meldung aufgehoben	00:07:01	00:02:03
018	Betriebsart ungleich AUTO	NAMUR-Meldung gesetzt	00:07:01	00:02:03
019	Verblockmodul geschaltet	NAMUR-Meldung gesetzt	00:07:01	00:02:03
020	Optionsmodule: Ungültige Kombination	NAMUR-Meldung gesetzt	00:07:01	00:02:03
021	Gerätestart	Aktion gestartet	00:07:01	00:02:03

Fig. 3: > *Diagnosis/maintenance* > *Device state* > *Logging*

5.3.1 Reset

	Initialization	'Reset logging'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset logging	NO	YES	NO	YES	YES

5.4 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 $-60\text{ }^{\circ}\text{C}$ and $80\text{ }^{\circ}\text{C}$ respectively by default. These settings can only be changed in the 'Customer expert' user level.

5.4.1 Reset

	Initialization	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset temperature values	YES	NO	NO	YES

6 Statistical information

The Statistical information 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.

6.1 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.



Tip

Data can also be saved manually by the command 'Save diagnostic data' in the [Diagnosis/maintenance > Device state] folder.

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

EXPERTplus has histograms on the following topics:

- Valve position (see section 6.1.2)
- Set point deviation (see section 6.1.3)
- Load cycle (see section 6.1.4)

The histograms can be displayed for different monitoring periods. The monitoring periods are indicated on the horizontal coordinate axis. By default, the entire valve life cycle is shown in the histogram. Other possible settings include:

Other possible settings include:

- Days (setting range: [Today], Yesterday, Day before yesterday, Three days ago, ..., Six days ago)
- Weeks (setting range: [This week], Last week, Week before last, Three weeks ago)
- Months (setting range: [This month], Last month, Month before last, Three months ago, ..., Eleven weeks ago)
- Years (setting range: [This year], Last year, Year before last, Three years ago, ..., Five years ago)

6.1.1 Reset

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

	Initialization	'Reset histograms'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset measured data	YES	YES	YES	YES	YES
Reset archived data	YES	YES	YES	YES	YES

Status messages generated as a result of the histogram analysis cannot be cleared manually. They are automatically cleared as soon as the conditions that caused the status messages to be generated no longer prevail.

6.1.2 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 pre-defined 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 $w \leq$ ' and 'End position $w \geq$ ' functions have been triggered.

- The 'End position $w \leq$ ' function causes the valve to move to the closed position when the valve position reaches an adjustable set point.

- The 'End position $w \geq$ ' function causes the valve to move to the maximum 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 maximum open position pinpoints to a valve that is too large or too small.

- We recommend checking the valve sizing.

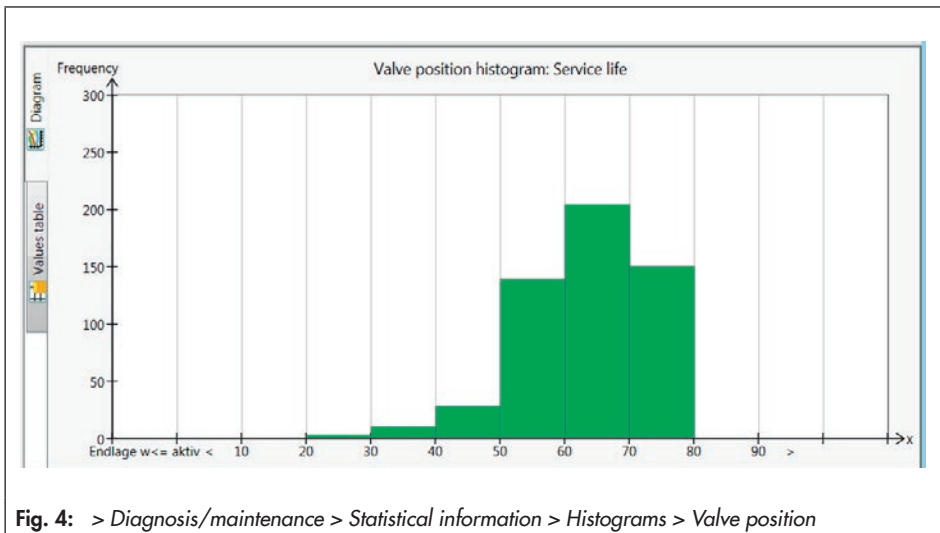


Fig. 4: > Diagnosis/maintenance > Statistical information > Histograms > Valve position

6.1.3 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 pre-defined 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.

→ We recommend 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.

→ We recommend 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 indicate that the actuator or valve stem is jammed.

→ We recommend checking the plug stem for external influences that could be blocking it.

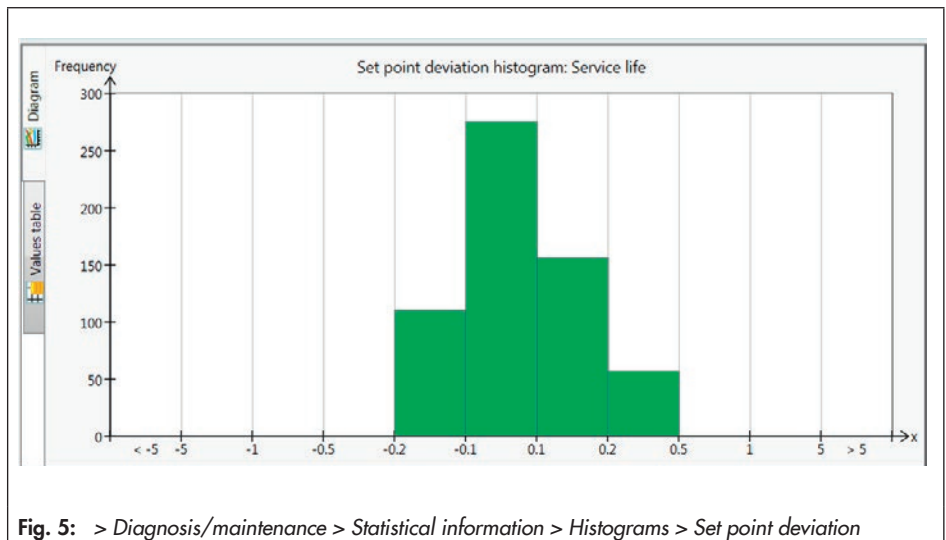


Fig. 5: > Diagnosis/maintenance > Statistical information > Histograms > Set point deviation

6.1.4 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 of a 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.

TROVIS 3793 > Diagnosis/maintenance > Device state

- Stem seal: [Not selected], Self-adjusting, Adjustable, Bellows, Other
- Max. cycle count: 1 to 100000000, [1000000]

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.

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.

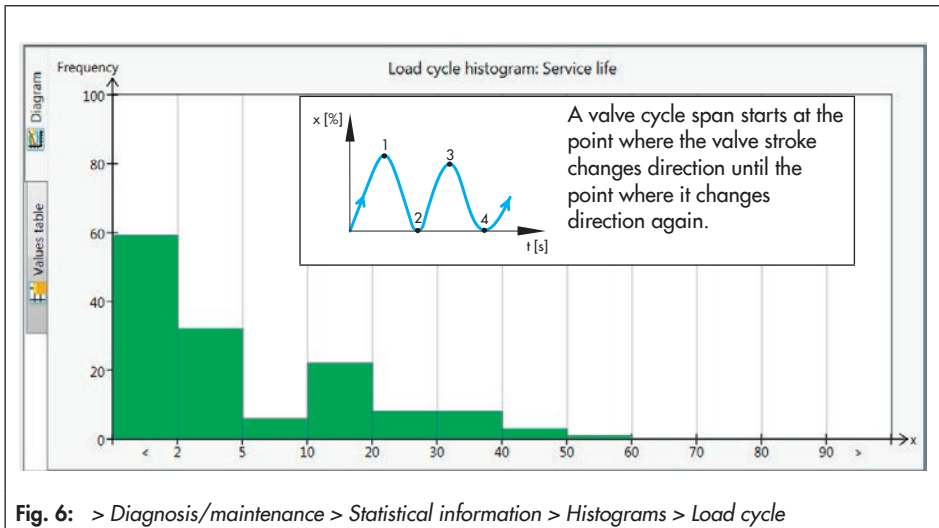







Fig. 6: > Diagnosis/maintenance > Statistical information > Histograms > Load cycle

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.

TROVIS 3793 > Diagnosis/maintenance > Device state
- Dynamic stress factor
TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification
- Dynamic stress factor exceeded:  [],  ,  , ]
TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages
- Dynamic stress factor exceeded

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

6.2 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 sections 6.2.1 and 6.2.2). 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

Statistical information

sections 6.2.1 and 6.2.2). It is shown as a straight line in the graph.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Course of end position

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

i 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.

6.2.1 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 = "Active").

TROVIS 3793 > Configuration > Set point processing

– Lower end position: [Active]

i 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.

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

– Lower end position shifted:



TROVIS 3793 > 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.

→ We recommend checking the seat and plug for wear.

i 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 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.

→ We recommend checking the plug stem for mechanical blockage.

6.2.1.1 Reset

See Table 2

6.2.2 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 maximum 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.

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

– Upper end position shifted:



> Diagnosis/maintenance > Device state > Status messages

– Upper end position shifted

➔ We recommend checking the plug stem for mechanical blockage when the status message is generated.

6.2.2.1 Reset

See Table 2

Table 2: *Reset the course of end position*

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

Statistical information

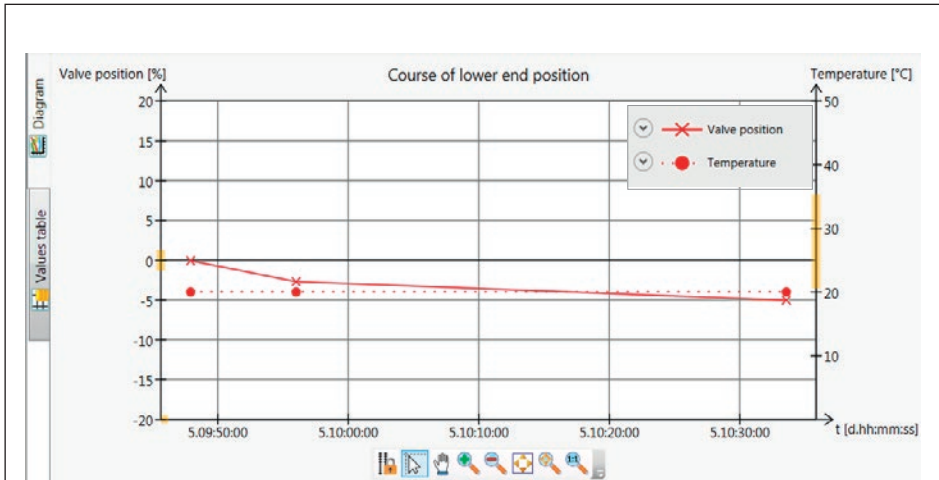


Fig. 7: > Diagnosis/maintenance > Statistical information > Course of lower end position

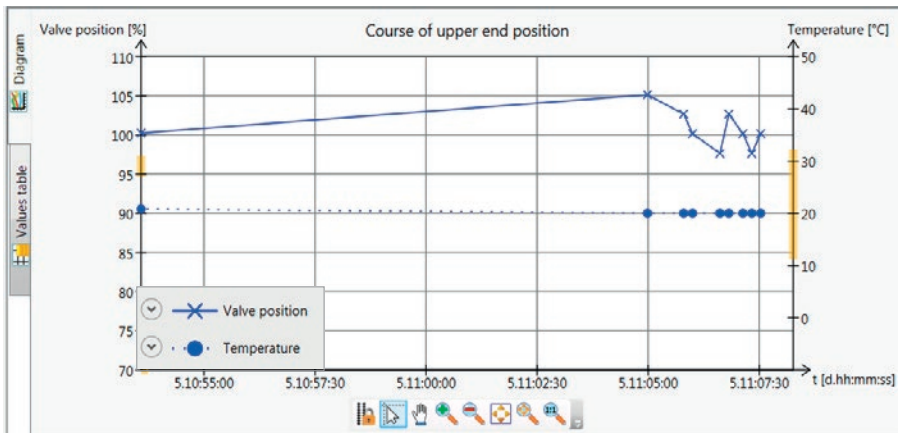


Fig. 8: > Diagnosis/maintenance > Statistical information > Course of upper end position

6.3 Course of supply pressure

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.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Course of supply pressure

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

6.3.1 Reset

	Initialization	'Reset course of supply pressure'	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset measured data	NO	YES	YES	YES	YES

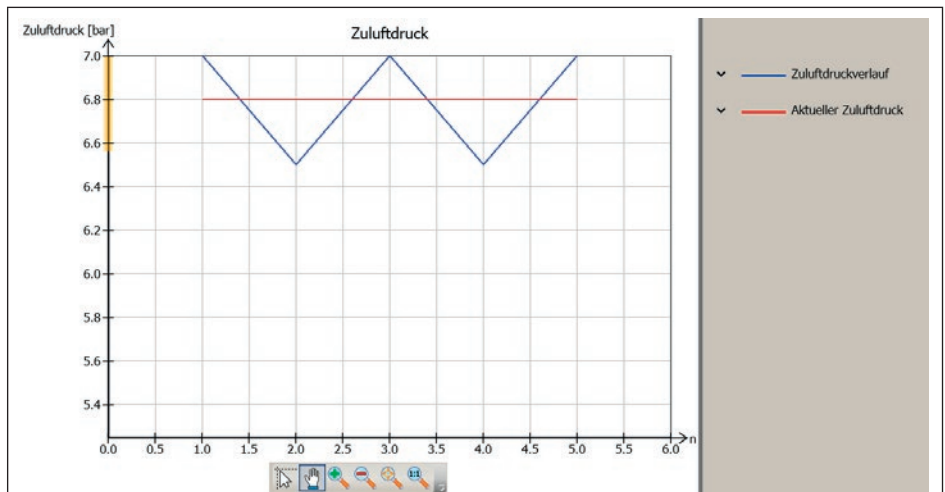


Fig. 9: Diagnostics > Monitoring/tests > Valve signature > Course of supply pressure

6.4 Valve signature

Requirements for the use of the 'Valve signature' diagnostic function:

The 'Pressure sensors' option is installed in the positioner (see nameplate and Table 1).

Valve signature (statistical information) only possible when the positioner is fitted with the optional pressure sensors.

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.

TROVIS 3793 > Configuration > Identification > Actuator

– Principle of operation: **Single-acting**

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

6.4.1 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 modules switch to open-loop control (control without feedback).

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

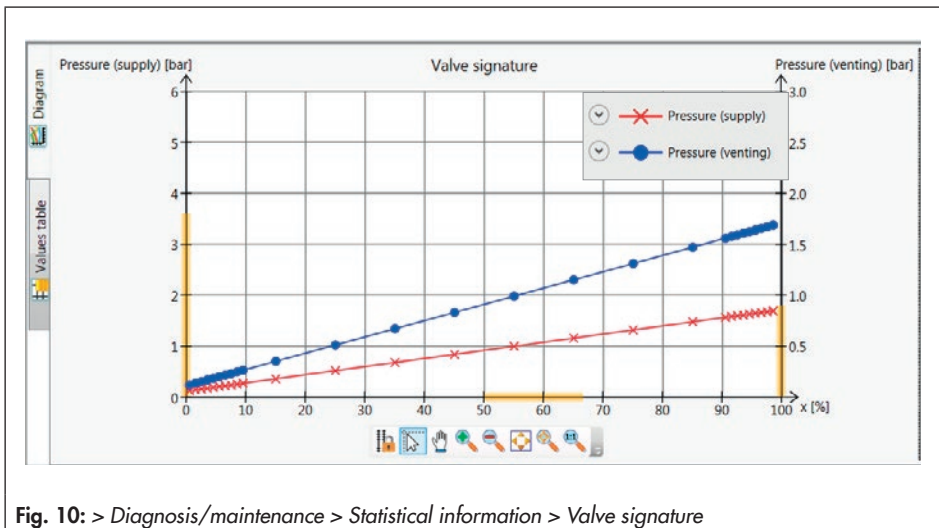


Fig. 10: > Diagnosis/maintenance > Statistical information > Valve signature

Recording the reference graph

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

TROVIS 3793 > Start-up

– Init. with valve signature: [Yes]

If a reference graph does not exist, the reference test can be started manually.

1. Switch to MAN mode.


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

TROVIS 3793

– Target operating mode: MAN

2. Start recording of reference graphs.

The 'Progress' reading shows the progress of the plotting of the reference graph in %.

'Function check'  is activated as the condensed state.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Valve signature

! Start reference
– Progress

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 hysteresis (average signal pressure difference in relation to the spring range)
- 'Min. hysteresis': lowest possible hysteresis (minimum signal pressure difference in relation to the spring range)
- 'Max. hysteresis': highest possible hysteresis (maximum signal pressure difference in relation to the spring range)
- 'Detected lower spring range value': Signal pressure p_{out} at minimum supply
- 'Detected upper bench range value': Signal pressure p_{out} when the actuator at maximum supply

The 'Valve signature canceled' status message is generated with the assigned status if the reference recording is canceled. A detailed description on the reasons for cancellation can be found in the 'Result of last valve signature' parameter.

The 'Valve signature status' parameter is set to 'Invalid' when not enough values have been recorded or the exhaust line is partly above the supply line in the graph. In this case, the measurement is not assessed.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Valve signature

- Valve signature status: Valid, Invalid
- Result of the last valve signature: Not executed, Successful, Canceled (man.) etc.

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

– Valve signature failed:



TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

– Valve signature failed

i Note

The valve signature can be recorded again at any time and compared with the reference (see section 7.4) to assess the valve performance.

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 > 10 bar'

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

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

- No supply press.:
- Low supply pressure:
- Supply pressure > 10 bar:

TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

- No supply pressure
- Low supply pressure
- Supply pressure > 10 bar

→ We recommend checking the supply pressure, supply pressure regulator and pneumatic connections after a status message has been generated.

6.4.1.1 Reset

	Initialization	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset status message	YES	YES	YES	YES

6.4.2 Monitoring

The positioner records the signal pressure (monitoring diagram) during closed-loop operation. It is compared with the reference graph. Additionally, the minimum, maximum and current supply pressure are shown in the graph.

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.

6.4.2.1 Reset

	Initialization	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset measured data (monitoring)	YES	YES	YES	YES
Reset status messages	YES	NO	NO	NO

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.

i Note

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

6.4.3 Friction

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










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.

Analysis and monitoring

The friction for the total range of the valve, the mid valve position and for the ranges near to 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.

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

- Friction change (open pos.): [↻], , , 
- Friction change (mid-pos.): [↻], , , 
- Friction change (closed pos.): [↻], , , 

TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

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

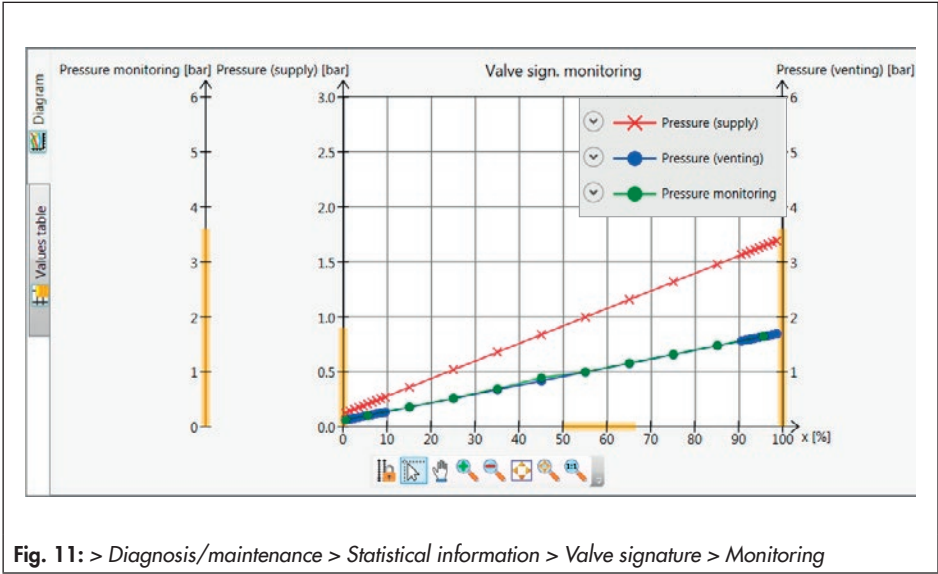


Fig. 11: > Diagnosis/maintenance > Statistical information > Valve signature > Monitoring

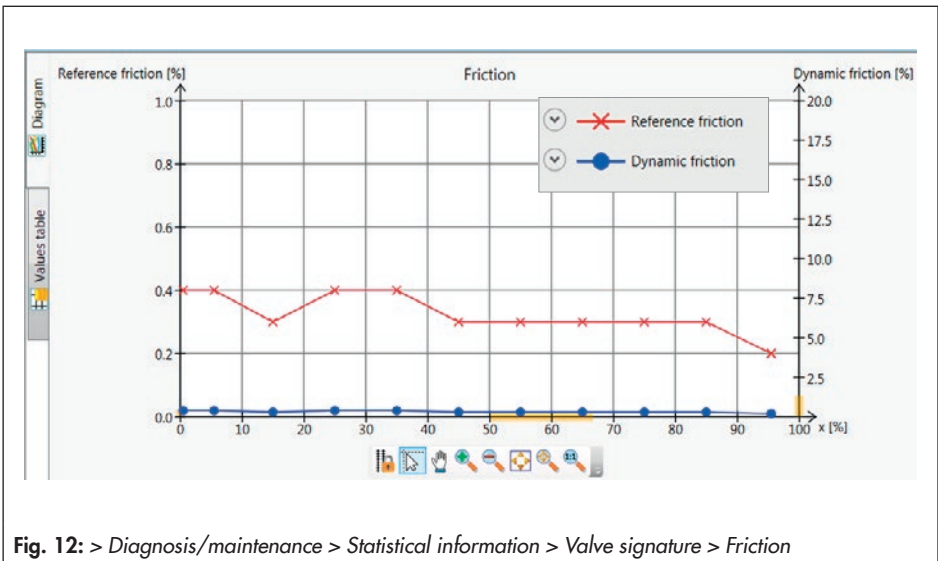


Fig. 12: > Diagnosis/maintenance > Statistical information > Valve signature > Friction

6.5 Leakage sensor

Leakage sensor (statistical information) only possible when the positioner has a mounted external leakage sensor (option module L).

By upgrading the positioner with a leakage sensor, it is possible to detect seat leakage when the valve is in the closed position. For this purpose, the leakage sensor amplifies the noise level in the tight shut position to detect increased seat leakage.

Requirements for using the seat leakage detection:

1. A leakage sensor is mounted on the valve (see the mounting and operating instructions of the positioner ▶ EB 8493).
2. The option module L (Z3799-xxx70) is installed in the positioner (see Table 1).
3. The tight-closing function is activated.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Leakage sensor

2. – Leakage sensor status: **Option active**

TROVIS 3793 > Configuration > Set point processing

3. – Lower end position: **[Active]**
– End position $w \leq 0.0$ to 49.9 %, [1.0 %]

Data are recorded in the background regardless of the operating mode selected. Data logging does not need to be activated.

The leakage sensor records the sound level when the valve leaves the tight shut position or whenever the sound level changes by the 'Recording threshold' value. The positioner saves the sound level values in a circular

buffer that holds 30 measured values at one time together with a time stamp.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Leakage sensor

- Recording threshold: 3 to 255 dB, [5 dB]











Analysis and monitoring

The 'Leakage: level limit 1 exceeded' alarm is generated with the assigned status classification when the level in the tight shut position exceeds the 'Threshold alarm 1'. The 'Leakage: level limit 2 exceeded' alarm is generated accordingly when the level exceeds the 'Threshold alarm 2'.

TROVIS 3793 > Diagnosis/maintenance > Statistical information > Leakage sensor

- Threshold alarm 1: 3 to 255 dB, [30 dB]
- Threshold alarm 2: 3 to 255 dB, [40 dB]

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

- Leakage: level limit 1 exceeded:
 [],  ,  , 
- Leakage: level limit 2 exceeded:
 [],  ,  , 

TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

- Leakage: level limit 1 exceeded
- Leakage: level limit 2 exceeded

6.5.3.1 Reset

	Initialization	'Reset diagnosis'	'Reset (standard)'	'Reset (advanced)'
Reset measured data	NO	YES	YES	YES
Reset status messages	NO	YES	YES	YES

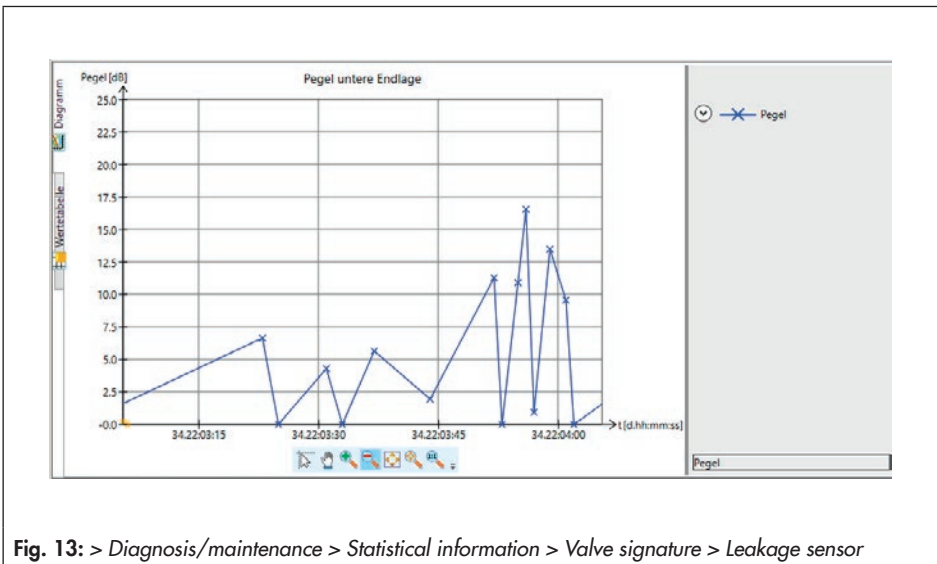


Fig. 13: > *Diagnosis/maintenance* > *Statistical information* > *Valve signature* > *Leakage sensor*

7 Tests

Similar to the statistical information, 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.

7.1 Partial stroke test (PST)

i Note

In older software versions, the term "step response test (SRT)" was used in place of "partial stroke test (PST)". 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. 14). The test is performed with the ramp function when the ramp times ('Ramp 1' and 'Ramp 2') are set to $\neq 0$ 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 time' defines the time interval between which the measured values are recorded during the test.

TROVIS 3793 > 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]
- Sampling rate (not write-enabled)

TROVIS 3793 > 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 $\neq 0$ %.

TROVIS 3793 > Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

- Canceled: max. dead time (not write-enabled)
- Dead time limit determined: 1 to 10 %, [2 %]

7.1.1 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 calculated by the positioner is reached.

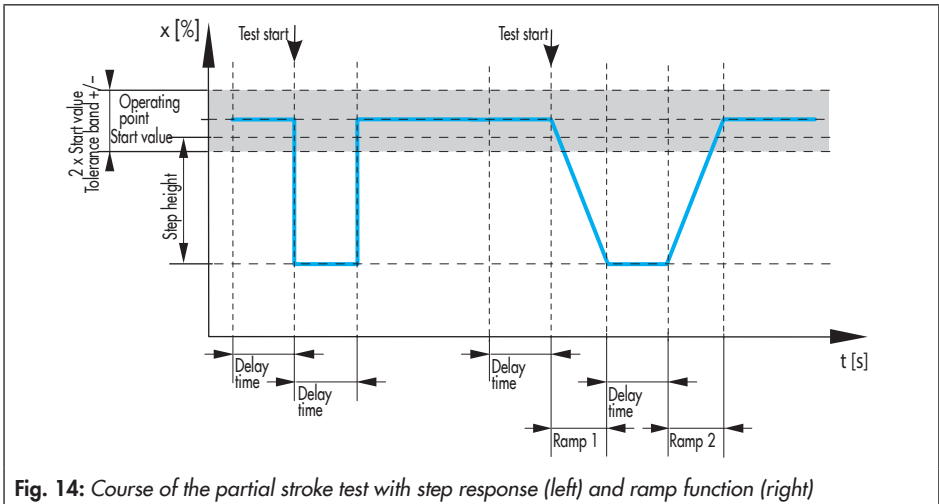


Fig. 14: Course of the partial stroke test with step response (left) and ramp function (right)

Tolerance bands

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

TROVIS 3793 > 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 $\neq 0$ %.

TROVIS 3793 > 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 $\neq 0$ %.

TROVIS 3793 > 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 (see Table 1).

- '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".



The minimum or maximum pressure of the reference test can be used as a guide for the limit defined in 'Canceled (press. limit)'. See section 7.1.3.

TROVIS 3793 > Diagnosis/maintenance > Tests > Partial stroke test (PST) > Configuration

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

i 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 canceled manually:
 - ➔ 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 +/-'.

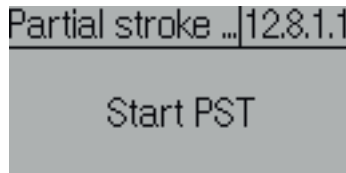
7.1.2 Test start


Table 3: Start conditions of partial stroke test

Operating mode	See section 7.1.2.1 for manual start (on site or using software)	Automatic start after 'Test interval' has elapsed (see section 7.1.2.2)	Start triggered by the binary input (see section 7.2.2.2)
AUTO	YES	YES	YES
MAN	YES	NO	YES

7.1.2.1 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 8493.
- Press  to start test.

i Note

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

Software command via TROVIS-VIEW/ integration

TROVIS 3793 > Diagnosis/maintenance > Tests
> Partial stroke test (PST)

! Start test

i Note

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

7.1.2.2 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 read in the 'Time until next test' information parameter.

TROVIS 3793 > 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

TROVIS 3793 > Diagnosis/maintenance > Tests
> Partial stroke test (PST)

- Time until next test (not write-enabled)

7.1.2.3 Start triggered by binary input

Function only possible when positioners has option module [T] or [V].

TROVIS 3793 > Configuration > Slots options >
Slot C

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

7.1.3 Analysis and monitoring

The analysis of the last fifty partial stroke test (PST) are 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.

i Note

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

Tests

Test completed successfully

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

- Time stamp
- Dead time: time from when the test starts until the first measurable movement of the valve.
- T98: time which the valve requires from the test start until it reaches 98 % of the final value in the idle state.
- Overshooting range: overshoot in relation to the step height
- Min. pressure: lowest pressure measured during the test.
- Test status
- Breakaway pressure: pressure required to move the valve from the idle position when the test starts

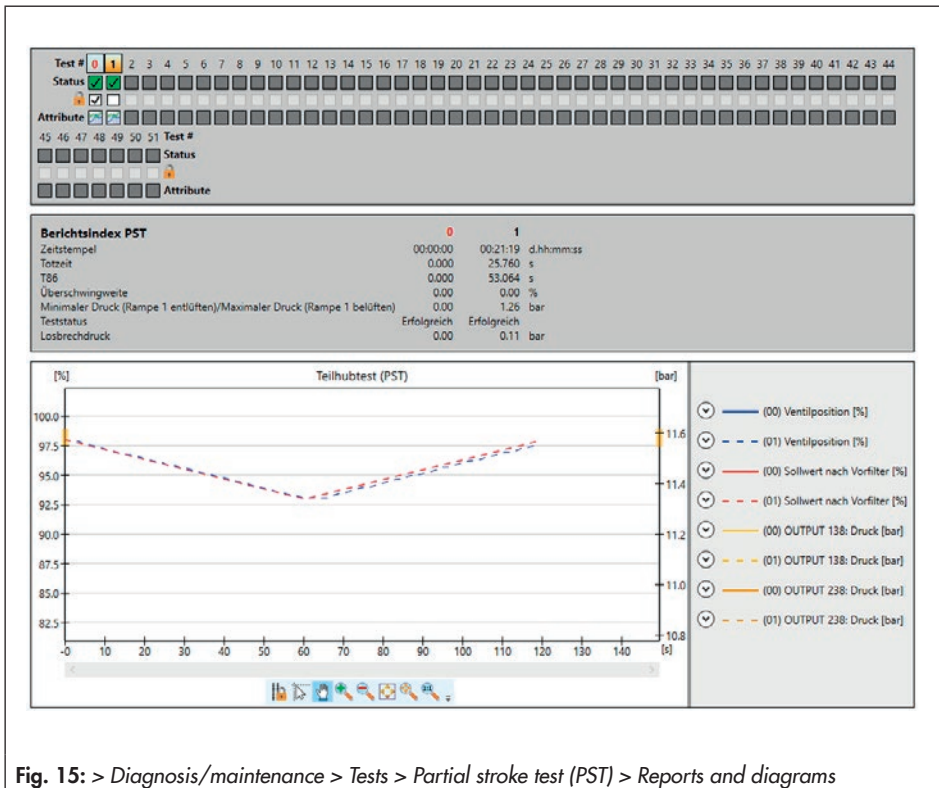


Fig. 15: > Diagnosis/maintenance > Tests > Partial stroke test (PST) > Reports and diagrams

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

TROVIS 3793 > 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 range (not write-enabled)
- Min. pressure (ramp 1; exhaust)/max. pressure (ramp 1; supply) (only with pressure sensors) (not write-enabled)
- Test status (not write-enabled)
- Breakaway pressure

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.

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

- PST: cancellation criteria met:  , , , 
- PST: start criteria not met:  , , , 

TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

- PST: cancellation criteria met
- PST: start criteria not met

Table 4: Recommended action when the status message is generated

	Test result	We recommend:
Test canceled	Current	➔ Check input signal
	Internal error	➔ Restart test
	Timeout	➔ Check seat and plug for deposits or foreign particles
	No movement possible	
Start criterion	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 3 and restart test.

Tests

Statistical analysis

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

TROVIS 3793 > 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)

7.1.4 Reset

See Table 5

Table 5: *Resetting the partial stroke test (PST)*

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

7.2 Full stroke test (FST)

i Note

In older software versions, the term "step response test (SRT-100 %)" was used in place of "full stroke test (FST)". The terms are synonymous and are used to describe the same test.

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. 16). The test is performed with the ramp function when the ramp time ('Ramp') is set to $\neq 0$ s.

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

Starting from the maximum open position, the valve moves to the closed position. The valve remains in this position for the time defined by the 'Delay time' before performing a second step change in the opposite direction from the closed position to the maximum open position. The 'Sampling time' defines the time interval between which the measured values are recorded during the test.

TROVIS 3793 > Diagnosis/maintenance > Tests > Full stroke test (FST) > Configuration

- Ramp 1: 0 to 9999 s, [60 s]
- Delay time: 0 to 240 s, [2 s]

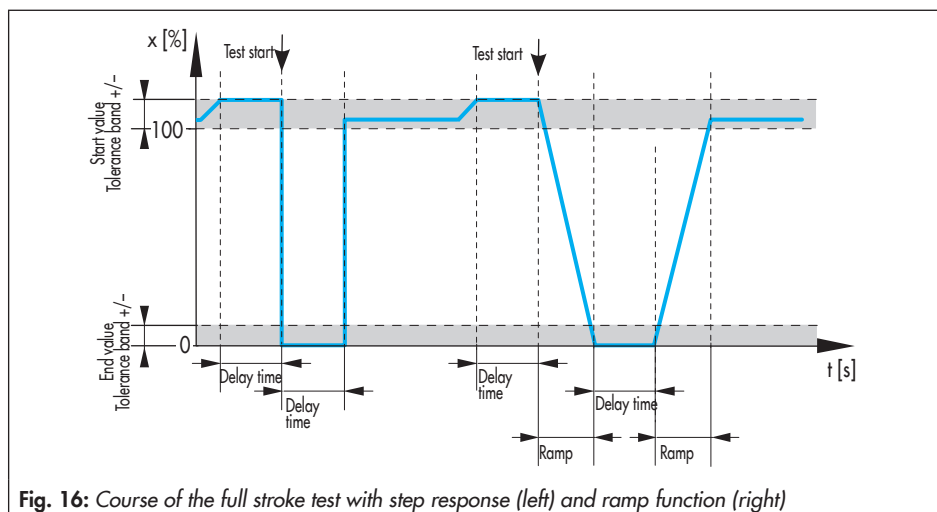


Fig. 16: Course of the full stroke test with step response (left) and ramp function (right)

7.2.1 Test cancellation criteria

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

Time

- 'Canceled: max. test duration': the test is canceled when the maximum permissible test duration calculated by the positioner is reached.

TROVIS 3793 > 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 if the operating point is outside the range: maximum open position - 'Start value of tolerance band +/-'.

TROVIS 3793 > 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 if the valve position after the first step does not reach the range: closed position + 'End value of tolerance band +/-'.

TROVIS 3793 > 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).

7.2.2 Test start

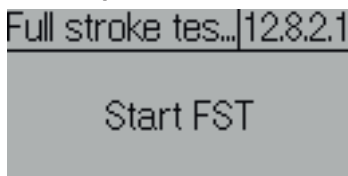
Table 6: Start conditions of full stroke test (FST)


Operating mode	See section 7.2.2.1 for manual start (on site or using software)	Start triggered by binary input (see section 7.2.2.2)
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.

7.2.2.1 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 8493.
- Press  to start test.

i Note

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

Software command via TROVIS-VIEW/ integration

TROVIS 3793 > Diagnosis/maintenance > Tests
> Full stroke test (FST)

! Start test

i Note

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

7.2.2.2 Start triggered by binary input

Function only possible when positioners has option module [T] or [V].

TROVIS 3793 > Configuration > Slots options > Slot C

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

7.2.3 Analysis and monitoring

The analysis of the last six full stroke test (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).

- Time stamp
- Dead time (rising): time until the first measurable movement of the valve from the closed position is detected.
- Dead time (falling): time until the first measurable movement of the valve from the maximum open position is detected.

Tests

- T86 (rising): time which the valve requires to move from the closed position until it reaches 86 % of the final value in the maximum open position.
- T86 (falling): time which the valve requires to move from the maximum open position until it reaches 86 % of the final value in the closed position.
- T98 (rising): time which the valve requires to move from the closed position until it reaches 98 % of the final value in the maximum open position.
- T98 (falling): time which the valve requires to move from the maximum open position until it reaches 98 % of the final value in the closed position.
- Test status
- Breakaway pressure: pressure required to move the valve from the idle position when the test starts

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

TROVIS 3793 > 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)

The results of the first full stroke test (FST) performed with the current configuration are used as a reference test and are write-pro-

TECTED. 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.

TROVIS 3793 > Diagnosis/maintenance > Configuration > Status classification

- FST: cancellation criteria met:
    
- FST: start criteria not met:
    

TROVIS 3793 > Diagnosis/maintenance > Device state > Status messages

- FST: cancellation criteria met
- FST: start criteria not met

Table 7: Recommended action when the status message is generated

	Test result	We recommend:
Test canceled	Current	→ Check input signal
	Internal error	→ Restart test
	Timeout	→ Check seat and plug for deposits or foreign particles
	No movement possible	
Start criterion	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 6 and restart test.

Statistical analysis

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

TROVIS 3793 > 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)

7.2.4 Reset

See Table 8

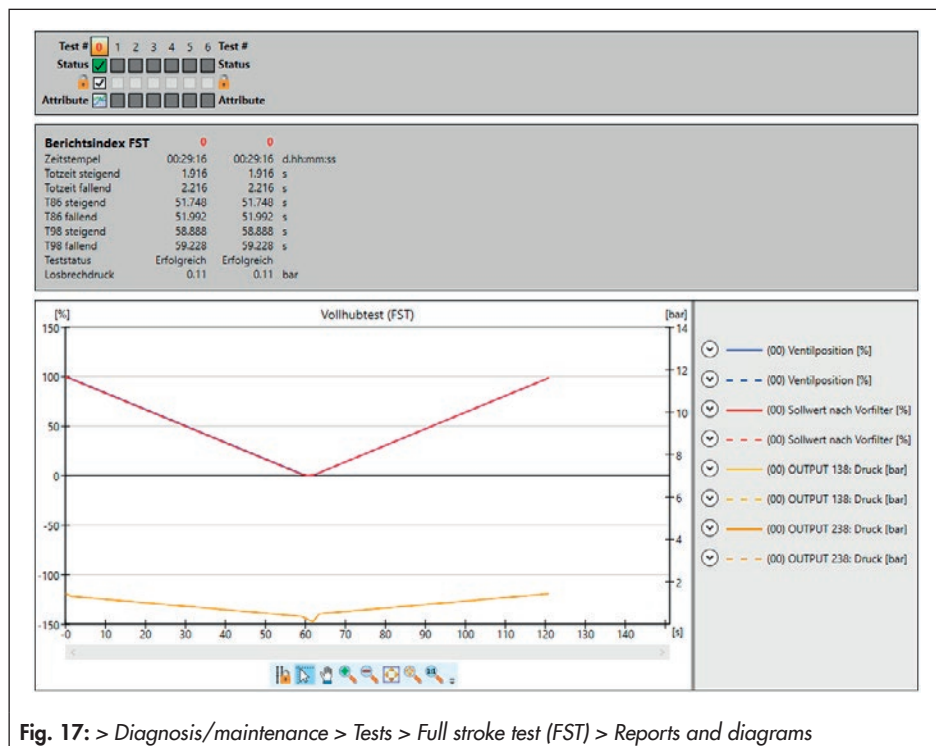


Fig. 17: > Diagnosis/maintenance > Tests > Full stroke test (FST) > Reports and diagrams

Table 8: Resetting the full stroke test

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

7.3 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' $\pm 1/2$ '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' $- 1/2$ 'Span' in 'Start direction' = 'Minus' or
- 'Start set point' $+ 1/2$ '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' $+ 1/2$ 'Span' in 'Start direction' = 'Minus' or
- 'Start set point' $- 1/2$ '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'.

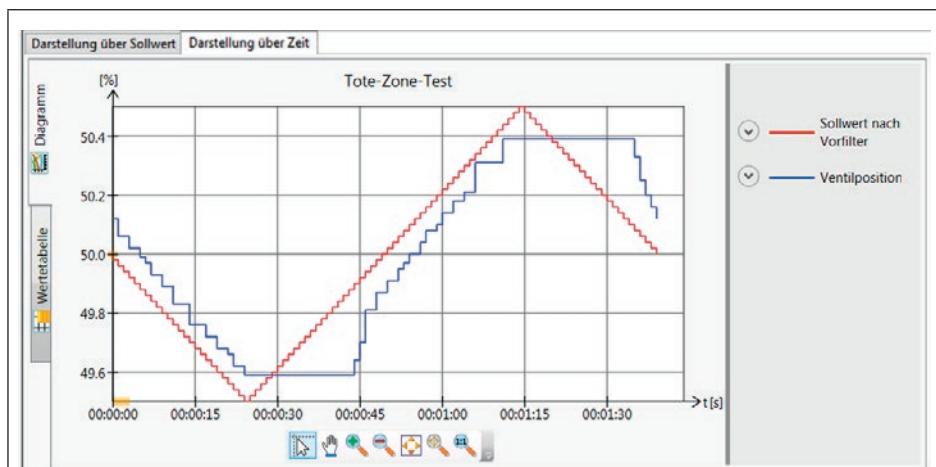


Fig. 18: > Diagnosis/maintenance > Tests > Dead band > Plotted over time

Tests

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:


- Plotting of the valve position [%] after filter [%] over set point [s]
- Plotting of the valve position [%] and the set point after filter [%] over time [s]

Defining parameters

1. Switch to MAN mode.
2. Select test parameters.
3. Start test.

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

The 'Test status' generates an 'Active' message.

'Function check'  is activated as the condensed state.

TROVIS 3793

1. – Target operating mode: MAN

TROVIS 3793 > Diagnosis/maintenance > Tests > Dead band > Configuration

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 dead band 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.

7.3.1 Reset

See Table 9


7.4 Valve signature (Tests)

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

The repetition test is performed in the same way as the plotting of the reference graph described in section 6.4.1: 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 modules switch 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 3793

1. – Target operating mode: MAN

TROVIS 3793 > 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.

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.

Reset

See Table 10

Table 10: 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

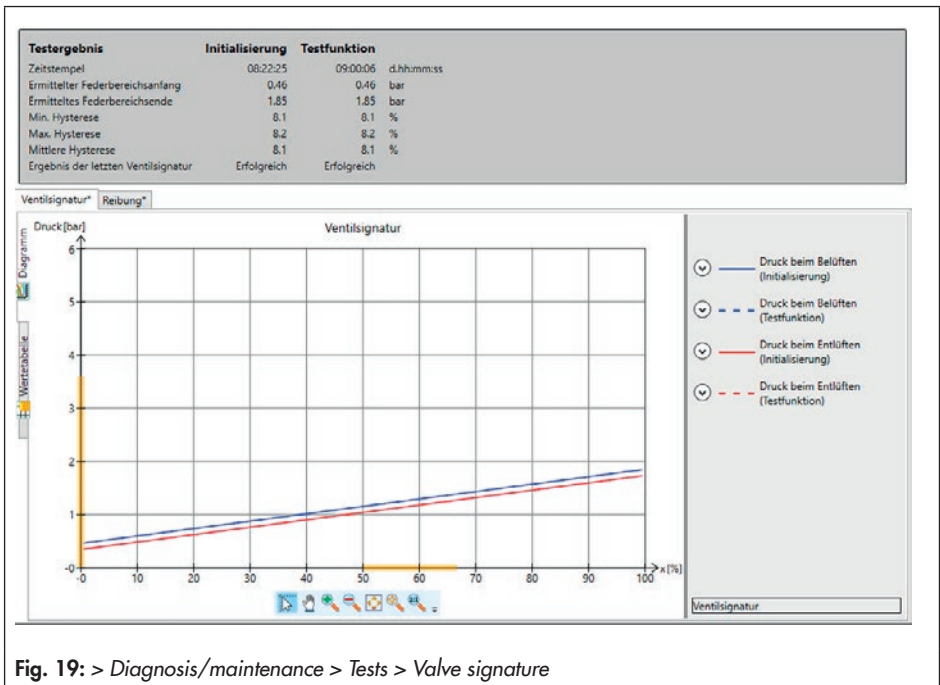


Fig. 19: > Diagnosis/maintenance > Tests > Valve signature

8 Error messages and recommended corrective action

Message	Recommended action	Status classification
> Diagnosis/maintenance > Device state > Status messages ... Control valve diagnosis		
Friction change (open pos.)	See section 6.3.	YES [◆]
Friction change (mid-pos.)	See section 6.3.	YES [◆]
Friction change (closed pos.)	See section 6.3.	YES [◆]
Valve sign. failed	<ul style="list-style-type: none"> → Check configuration. → Restart valve signature. → Initialize positioner with setting 'Init. with valve signature' = Yes. 	YES [◆]
No supply press.	<ul style="list-style-type: none"> → Check air supply. → Check air lines/connections. 	YES [▲]
Low supply pressure	<ul style="list-style-type: none"> → Check air supply. → Check supply pressure regulator. → Check air lines/connections. 	YES [◆]
Supply pressure > 10 bar	<ul style="list-style-type: none"> → Check air supply. → Check supply pressure regulator. 	YES [▲]
PST: cancellation criteria met	See section 7.1.	YES [◆]
PST: start criteria not met	See section 7.1.	YES [■]
FST: cancellation criteria met	See section 7.2.	YES [◆]
FST: start criteria not met	See section 7.2.	YES [■]
P3799: failure	<ul style="list-style-type: none"> → Check air quality. → Contact SAMSON's After-sales Service. 	YES [highest classification]
P3799: movement impaired	<ul style="list-style-type: none"> → Check air supply. → Contact SAMSON's After-sales Service. 	YES [highest classification]
P3799: maintenance required	→ Check air supply.	YES [highest classification]
P3799: initialization error	→ Contact SAMSON's After-sales Service.	YES [highest classification]
AMR signal outside range	→ Check attachment.	YES [◆]
Hardware error	<ul style="list-style-type: none"> → Confirm error and select AUTO operating mode. → Re-initialize positioner. 	YES [highest classification]

Error messages and recommended corrective action

Message	Recommended action	Status classification
Limit for total valve travel exceeded	→ Check valve and attachment for signs of wear.	YES [◆]
Lower end position shifted	→ Check plug and seat for wear (see section 6.2).	YES [◆]
Upper end position shifted	→ Check plug and seat for wear (see section 6.2).	YES [◆]
Dynamic stress factor exceeded	→ Check the state of the valve packing (see section 6.1.4).	YES [◆]
Set point deviation	→ Check attachment. → Check air supply. → Check air lines/connections.	YES [◆]
Brownout	→ Check power supply/input signal.	YES [◆]
Current too low	→ Check power supply/input signal.	YES [▲]
IP shutdown	→ Check power supply/input signal.	YES [■]
Current too high	→ Check power supply/input signal.	YES [▲]
Angle limitation	→ Check attachment.	YES [highest classification]
Temperature inside device below min. limit	→ Check the installation of the control valve concerning possible environmental and ambient influences. If necessary, protect the control valve better against environmental influences.	YES [▲]
Temperature inside device above max. limit	→ Check the installation of the control valve concerning possible environmental and ambient influences. If necessary, protect the control valve better against environmental influences.	YES [▲]
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 supply pressure. → Check whether another valve can be used.	YES [■]

Message	Recommended action	Status classification
Operating range in max. OPEN position	<ul style="list-style-type: none"> → Check attachment. → Check supply pressure. → Check whether another valve can be used. 	YES [✓]
Operating range shifting towards CLOSED position	<ul style="list-style-type: none"> → Rethink the working range. 	YES [✓]
Operating range shifting towards max. OPEN position	<ul style="list-style-type: none"> → Rethink the working range. 	YES [✓]
Limited working range: lower range	<ul style="list-style-type: none"> → 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	<ul style="list-style-type: none"> → Check that pneumatic installations and connections are tight. → Check supply pressure. → Check plug stem for external influences that could be blocking it. 	YES [✓]
Leakage: level limit 1 exceeded	<ul style="list-style-type: none"> → Check plug and seat for wear. 	YES [◆]
Leakage: level limit 2 exceeded	<ul style="list-style-type: none"> → Check plug and seat for wear. 	YES [◆]
Fail-in-place module	<p>Fail-in-place module has been activated. No action possible. The error message is cleared as soon as the conditions that caused the status messages to be generated no longer prevail.</p> <p>If the error message does not clear:</p> <ul style="list-style-type: none"> → Contact SAMSON's After-sales Service. 	YES [✗]

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