

Series 373x Positioners
EXPERTplus Valve Diagnostics

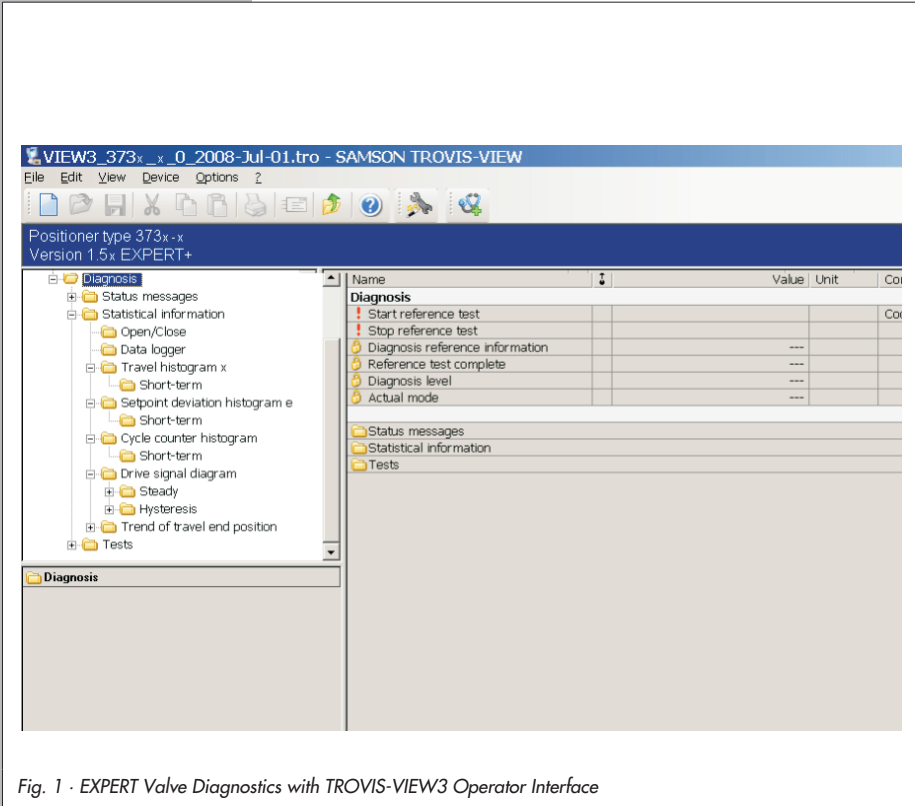


Fig. 1 · EXPERT Valve Diagnostics with TROVIS-VIEW3 Operator Interface

Operating Instructions

EB 8389 EN

Firmware version 1.5x
Edition June 2012

Definitions of the signal words used in these instructions

NOTICE

NOTICE indicates a property damage message.

Note: *Supplementary explanations, information and tips*

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Note: The screen shots in these instructions are used to illustrate the appearance of TROVIS-VIEW. Certain details on screen may differ.

1 Description

1.1 General

These instructions EB 8389 EN supplement the standard Mounting and Operating Instructions for Type 3730 and Type 3731 Positioners with firmware version 1.51 and higher.

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

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

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

Operation using TROVIS-VIEW3/DD/DTM/EDD

Using the TROVIS-VIEW3 software or DD/DTM/EDD, EXPERTplus allows the parameters to be viewed and set conveniently.

All the parameter settings that are changed over the operator interface must also be downloaded onto the positioner to allow them to become effective.

On-site operation

The parameters of partial stroke test can be configured and the test started at the positioner itself. All parameters that can be changed at the positioner are also assigned a code in addition to the parameter name.

To change these parameters, the configuration of the positioner needs to be enabled first using Code 3. Refer to standard instructions of the positioners.

Note: The operation described in the following sections is performed in the TROVIS-VIEW3 software.

Installation and operation of TROVIS-VIEW3 is described in the standard instructions (Table 1).

Positioners	Standard instructions
Type 3730-2	EB 8384-2 EN
Type 3730-3	EB 8384-3 EN
Type 3730-4	EB 8384-4 EN
Type 3730-5	EB 8384-5 EN
Type 3731-3	EB 8387-3 EN
Type 3731-5	EB 8387-5 EN

Table 1 · Standard instructions

1.2 Diagnostic functions

There are two main groups of diagnostic functions available: **Statistical information** (in-service monitoring) and **Tests** (out-of-service diagnostics).

Table 2 contains a summary of the diagnostic functions and what insight they provide about the state of the control valve.

Statistical information

Data are recorded while the process is running without disrupting the process.

Tests

These tests are performed in the manual mode (**MAN**) as the positioner cannot follow the reference variable to control the position of the valve at the same time. The valve moves to a certain position defined by the test settings and the valve moves through its full working range.

Note: *In the event that the optional solenoid valve is triggered or the forced venting function is activated, an active test is stopped and the positioner changes to the fail-safe position.*

Statistical information	Test analysis
Open/Close (not Type 3730-4)	Breakaway time, transit time, valve end position
Data logger	According to trigger status
Travel histogram x	Shifting working range, working range
Setpoint deviation histogram e	Limit working range, inner leakage, connection positioner - valve, absolute value of max. setpoint deviation
Cycle counter histogram	External leakage, dynamic stress factor
Drive signal diagram · Steady-state	Air supply, leakage pneumatics
Drive signal diagram · Hysteresis	Friction, external leakage
Trend of travel end position	Observing end position, zero point shift
Tests	Test analysis (over the working range of the valve)
Drive signal diagram steady-state	Air supply, leakage pneumatics, actuator springs
Drive signal diagram hysteresis	Friction, external leakage
Static characteristic	Dead band
Partial stroke test (PST)	Overshoot, dead time, T63, T98, rise time, settling time
Full stroke test (FST)	Overshoot, dead time, T98, rise time, settling time
Table 2 · Diagnostic functions and test analysis	

1.3 Application type





Two types of valves are available: **Control valve** and **Open/Close (on/off) valve**. The MAN and AUTO operating modes can be selected with both types of valves.

Depending on the type of valve that has been selected, the positioner has different diagnostic functions (Table 3) and behaves differently in the automatic mode (AUTO) (see Table 4).

Positioner – Start-up

- Application type (Code 49 - h0): [Control valve], Open/Close valve

Note: The application type cannot be selected for Type 3730-4. This positioner always has the "control valve" application type.

Application type	Control valve		Open/Close valve	
Operating mode	AUTO 	MAN 	AUTO 	MAN 
Statistical information				
Open/Close	–	–	•	–
Data logger	•	•	•	•
Travel histogram x	•	•	•	•
Setpoint deviation histogram e	•	•	•	•
Cycle counter histogram	•	•	•	•
Drive signal diagram · Steady-state	•	•	⊗	⊗
Drive signal diagram · Hysteresis	•	•	⊗	⊗
Trend of travel end position	•	•	•	•
Tests				
Drive signal diagram steady-state	–	•	–	•
Drive signal diagram hysteresis	–	•	–	•
Static characteristic	–	•	–	•
Partial stroke test	–	•	•	•
Full stroke test	–	•	–	•
<ul style="list-style-type: none"> • Test is performed – Test cannot be performed ⊗ Test is performed, but not analyzed (i.e. a message is not generated) 				
<i>Table 3 · Diagnostic functions</i>				



	Control valve	Open/Close valve
AUTO mode 	<p>The positioner follows continuously the reference variable.</p> <p>The valve position (current position) appears in % on the display.</p>	<p>Discrete analysis of the reference variable.</p> <p>The valve position (current position) in % and O/C (Open/Close) appear in alternating sequence on the display.</p>
MAN mode 	The positioner follows the reference variable given over local operation or over acyclic communication.	

Table 4 · Behavior in automatic (**AUTO**) and manual (**MAN**) modes

1.3.1 Discrete analysis in open/close valves

Note:

- The travel range of open/close valves is defined using the fail-safe position and the given Operating point. As a result, the following parameters to define the operating range and the range of the reference variable cannot be changed or analyzed:
Travel/angle range start (Code 8) Travel/angle range end (Code 9)
Travel/angle lower limit (Code 10) Travel/angle upper limit (Code 11)
Reference variable range start (Code 12) Reference variable range end (Code 13)
- The "open/close" application type cannot be selected for Type 3730-4.

The reference variable of open/close valves is discretely analyzed in automatic operating mode (**AUTO**):

Fig. 2 A

If the reference variable is below *Limit operating point* at the start of automatic opera-

tion, the valve moves to the fail-safe position. If the reference variable increases and exceeds the *Limit operating point*, the valve moves to the *Operating point*. The valve moves back to the fail-safe position if later the reference variable falls below the *Limit fail-safe position*.

Fig. 2 B

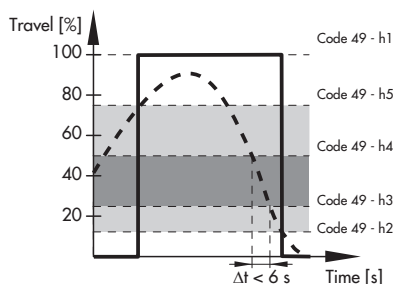
If the reference variable is above *Limit operating point* at the start of automatic operation, the valve moves to the *Operating point*. If later the reference variable drops below the *Limit fail-safe position*, the valve moves to the fail-safe position.

Starting the partial stroke test (PST)

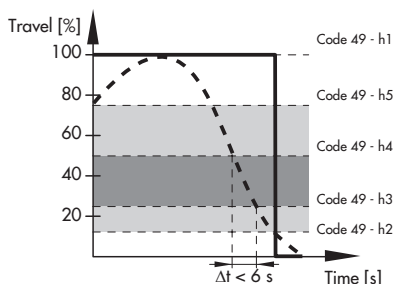
Figs. 2 C and D

A partial stroke test is started when the reference variable moves from a defined position (fail-safe position or *Operating point*) into the range between *Lower limit test start* and *Upper limit test start* and remains there for longer than six seconds. The valve moves from the last defined position to *Step start*.

A

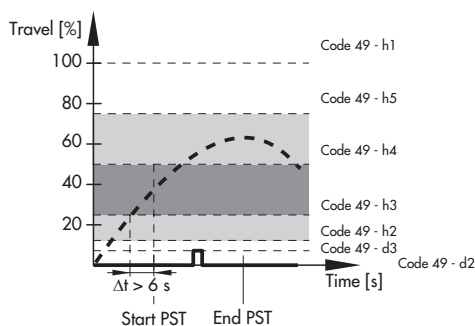


B

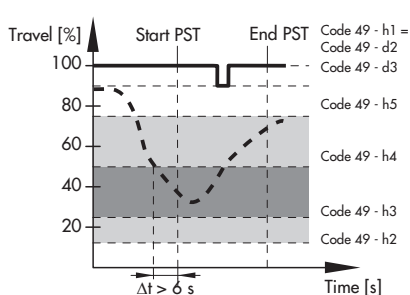


Starting the partial stroke test (PST)

C



D



— — — Reference variable w
 ————— Valve position x

Example:

Fail-safe position: 0 %
 Operating point: 100 %

Code 49 - d2: Step start
 Code 49 - d3: Step end
 Code 49 - h1: Operating point
 Code 49 - h2: Limit fail-safe position
 Code 49 - h3: Lower limit test start
 Code 49 - h4: Upper limit test start
 Code 49 - h5: Limit operating point

Fig. 2 · Open/close valve: Discrete analysis of the reference variable in AUTO mode

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

Note: The partial stroke test (PST) is performed according to the settings in the Diagnosis folder (> Tests > Partial Stroke Test). See section 5.

Cancellation of the partial stroke test (PST)

The partial stroke test is cancelled whenever the reference variable leaves the range between *Limit fail-safe position* and *Limit operating point*.

After the test has been cancelled, the valve moves back to its last position (fail-safe position or *Operating point*).

Positioner – Reference variable

- Operating point (Code 49 - h1):
0.0 to 100.0 %, [100.0 %]
- Limit fail-safe position (Code 49 - h2):
0.0 to 20.0 %, [12.5 %]
- Lower limit test start (Code 49 - h3):
25.0 % (cannot be changed!)
- Upper limit test start (Code 49 - h4):
50.0 % (cannot be changed!)
- Limit operating point (Code 49 - h5):
55.0 to 100.0 %, [75.0 %]

1.4 Requirements for diagnostics

For the correct analysis of diagnostic data, the positioner must be initialized. In addition, the valve diagnostics requires specifications to be entered concerning the valve packing, type of actuator and whether the actuator is fitted with a booster.

Identification – Positioner – Actuator

- Model: [-/-], Single-acting, Double-acting, Other ¹⁾
- Booster: [-/-], Not present, Present, Other ²⁾


Identification – Positioner – Valve

- Stuffing box: [-/-], Self-adjusting, Adjustable packing, Bellows seal, Other ³⁾

¹⁾ "Single-acting" is used when "Other" or [-/-] is selected.

²⁾ "Present" is used when "Other" is selected. "Not present" is used when [-/-] is selected.

³⁾ The diagnostics additionally analyses *Max. cycle counter limit* parameter for more information when "Other" is selected. "Self-adjusting" is used when [-/-] is selected.

Note: You can perform a simple start-up (initialization and specification of essential actuator and valve data) in TROVIS-VIEW3 with the help of the Start-up Wizard ( button).

Reference graphs

To analyze the latest measured data, *Drive signal diagram steady-state* (d1) and *Drive signal diagram hysteresis* (d2) for statistical information (in-service monitoring) and tests (out-of-service diagnostics) require reference data.

Right-click *Start reference test* (Code 48 - d7) in the *Diagnosis* folder and select *Execute* to start the recording of reference data.

NOTICE

The control valve moves through its working range during the reference test.

Note: *The positioner records the reference data automatically after initialization if the Initialization with reference test (Code 48 - h0) is set to Yes (default: No) in the Positioner folder (> Start-up).*

The tests *d1* (drive signal diagram steady-state) and *d2* (drive signal diagram hysteresis) are performed during the reference test.

IES1 and **d1** or **d2** appear in alternating sequence on the positioner display.

A new reference test causes any existing reference graphs to be overwritten and diagnostic data to be deleted.

If the reference data could not be recorded correctly or are incomplete, Code 81 - h1 is set at the positioner. If the *Initialization with reference test* parameter (Code 48 - h0) is activated, a incorrect reference test is also indicated in Code 81.

The positioner can perform its control task properly even if the reference test was not recorded correctly or is incomplete.

Note: *Data from the first reference test are used as reference if no reference data are saved in the positioner on starting the tests for Drive signal diagram steady-state (d1) or Drive signal diagram hysteresis (d2).*

1.5 Scope of functions

Observe the following points when the positioner is initialized in **SUB** (substitute calibration) mode or when a double-acting actuator and/or booster is used:

Positioner initialization using SUB (substitute calibration) mode, without initialization

- ▶ A reference test cannot be started.
- ▶ It is not possible to start all tests (out-of-service diagnostics) in one sweep.
- ▶ The *Drive signal diagram steady-state* or *Drive signal diagram hysteresis* in statistical information (in-service monitoring) and tests (out-of-service diagnostics) cannot be started.
- ▶ It is not recommended to activate the partial stroke test with cancellation conditions.

Double-acting actuator with reversing amplifier

- ▶ The reference test cannot be started.
- ▶ The *Drive signal diagram steady-state* or *Drive signal diagram hysteresis* in statistical information (in-service monitoring)

and tests (out-of-service diagnostics) cannot be started.

- ▶ It is not recommended to activate the partial stroke test with cancellation conditions.

Actuators with boosters

- ▶ The *Drive signal diagram steady-state* or *Drive signal diagram hysteresis* in statistical information (in-service monitoring) are performed, but cannot be analyzed.
- ▶ Depending on the hysteresis of the booster, the reference graphs in *Drive signal diagram hysteresis (d2)* cannot be plotted.
- ▶ High-frequency overshooting may occur in the partial stroke test if a booster is used.

As a result, *x control value* and *PST tolerance band* parameters must be adapted from their default settings.

Open/close valves

- ▶ The *Drive signal diagram steady-state* or *Drive signal diagram hysteresis* in statistical information (in-service monitoring) and tests (out-of-service diagnostics) are performed, but not analyzed.

Note: If the reference data could not be recorded correctly or are incomplete, Code 81 - h1 is set.

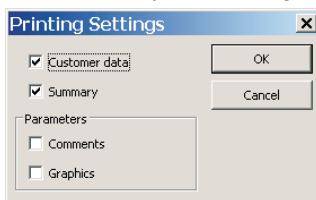
1.6 Printing the diagnostic log

The *Print* command allows you to print out a diagnostic log of individual tests or the entire diagnosis.

The diagnostic log includes a title page and a list of all the data points including all their values and properties.

The title page contains all key information for clear identification of the printed log (device type, file name, time and date of creation, time and date of the last change and TROVIS-VIEW3 version).

1. In the *File* menu, select *Print Options* to choose the scope of the diagnostic log.



After installing/updating the TROVIS-VIEW3 software, customer data (*Customer data* in the *Edit* menu) and summary (table of contents) are listed in the diagnostic log by default.



Check the check boxes for *Comments* and *Graphics* options to add these options to the diagnostic log.

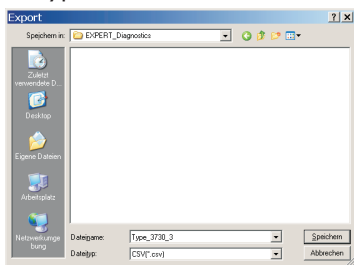
2. Click *OK* to confirm settings.
3. Right-click the *Diagnosis* folder or the required subfolder and select *Print* from the context-sensitive menu to print the diagnostic log.


The printout contains the contents of the folder and its subfolders.

1.7 Exporting measured data

You can export measured data compiled in statistical information (in-service monitoring) and tests (out-of-service diagnostics) as CSV, XML or XLS files.

1. Open the required *Statistical information* folder or *Tests* folder.
2. Click  button located underneath the graph to open the Table of values.
3. Export data by clicking  button.
4. Save data to any selected folder and name the file as required, selecting the file type.



5. Click  button to return the graph of measured data.

2 Status messages

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

There are two types of status messages: **standard status messages** and **extended status messages**.

You will find the status messages in TROVIS-VIEW3 in the *Diagnosis* folder (> *Status messages*) and (> *Status messages* > *Extended*).

Standard status messages

Standard status messages contain information on start-up as well as on operation and state of the positioner.

Messages are divided into the following main groups:

- ▶ Status
- ▶ Operation
- ▶ Hardware
- ▶ Initialization
- ▶ Data memory
- ▶ Temperature

Note: *Standard status messages are indicated in the positioner by the codes listed in the standard positioner instructions.*

Additional informative data are listed in the subfolders of the *Positioner* folder:

- ▶ *Positioner* folder (> *Process data*)
Information current process variables condensed status, operating mode, limit switches, temperature

- ▶ *Positioner* folder (> *Error control*)
Information on total travel with a freely defined limits
- ▶ *Positioner* folder (> *Start-up* > *Initialization*)
List of initialization errors, which can also be found in the *Diagnosis* folder (> *Status messages*)

Note: *The Trend Viewer function (activate Trend Viewer in the View menu) allows process variables to be shown in one or more graphs. You can add process variables to the graph by dragging and dropping them.*

Extended status messages

The extended status messages are generated from the results gained from *Statistical information* (in-service monitoring) and *Tests* (out-of-service diagnostics).

The messages provide information on the following topics to allow users to plan predictive maintenance and service work:


- ▶ Air pressure
- ▶ Shifting working range
- ▶ Leakage in the pneumatics
- ▶ Restriction of working range
- ▶ End position trend
- ▶ Mechanical connection linking positioner/control valve
- ▶ Working range
- ▶ Friction
- ▶ Actuator springs
- ▶ Seat leakage
- ▶ Leakage to the atmosphere
- ▶ PST (partial stroke test)/FST (full stroke test)
- ▶ Open/Close (not Type 3730-4)

Note: Any active diagnostic alarm is indicated in the positioner by Code 79.

2.1 Condensed state

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

The condensed state appears in TROVIS-VIEW3 on the right-hand side of the info bar and in the *Diagnosis* folder (> Status messages) and in the *Positioner* folder (> Process data).

Note: Condensed state and status messages are marked with  in TROVIS-VIEW3 until they are read out.

The condensed state can be read on the display of the positioner. See Table 5.

PROFIBUS PA communication

In Type 3730-4 Positioners, generated messages can be condensed and classified according to Profibus Profile 3.01 and the extension “Condensed Status and diagnostic messages”. Refer to the standard instructions of the Type 3730-4 Positioner.

FOUNDATION™ fieldbus communication

In Types 3730-5 and 3731-5 Positioners, the condensed state can also be read out at the CONDENSED_STATE parameter in the Resource Block and at the OUT_D parameter in the DI Function Blocks. Refer to the standard instructions of the Type 3730-5 or Type 3731-5 Positioners.









Status message	TROVIS-VIEW3/DTM	Positioner
No message, OK	 green	
Function check	 orange	Text e.g. <i>tESing</i> , <i>tunE</i> or <i>tESi</i>
Maintenance required/ Maintenance demanded	 blue	
Out of specification	 yellow	 blinking
Maintenance alarm	 red	

Table 5 · Condensed state

Condensed state at the fault alarm output

In positioners with a fault alarm output (Type 3730-2/-3, option in Type 3731-3), the condensed state is additionally issued at the fault alarm output if one of the following conditions met:

- ▶ "Maintenance alarm" is set as the condensed state.
- ▶ "Maintenance required" is set as the condensed state and the "Fault alarm at 'Maintenance required' condensed state" is activated.
- ▶ "Function check" is set as the condensed state and "Fault alarm at 'Function check' condensed state" is activated.

Positioner – Error control

- Fault alarm at condensed state 'Function check' (Code 32): [Yes], No
- Fault alarm at condensed state 'Maintenance required' (Code 33): [Yes], No






2.2 Classification of the status messages

The *Positioner* folder (> *Error control* > *Classification report*) contains a list of all the **standard status messages**.

The *Positioner* folder (> *Error control* > *Classification report* > *Extended*) contains the **extended status messages** which the positioner generated from statistical information (in-service monitoring) and tests (out-of-service diagnostics).

The classification of status messages can be changed as required. Classified messages are included in the condensed state of the positioner according to their assigned state.

Note: *Extended status messages marked "(TEST)" were detected during out-of-service diagnostics (Tests). All other extended status messages were identified based on information from in-service monitoring (Statistical information).*

Status message	TROVIS-VIEW3/DTM
No message	 white
Function check (Types 3730-4 and 373x-5)	 orange
Maintenance required/ Maintenance demanded	 blue
Out of specification	 yellow
Maintenance alarm	 red
Table 6 · Possible status classifications of a single message	

All **extended status messages**, apart from the PST/FST alarm, have the “No message” status by default.

The PST/FST alarm (Code 49 - A4) is set to “Maintenance required” by default.

On resetting the positioner parameters over *Start with default values* command (Code 36 - Std), the status classifications are also reset to their default settings (see section 2.3.1).

The following classifications are possible:

No message

If an event is classified as “No message”, this event does not have any affect on the condensed state of the positioner.

Function check

Test or calibration procedures are performed in the positioner. The positioner is temporarily unable to follow its control task as long as the procedure is taking place.

Maintenance required/Maintenance demanded

The positioner still performs its control task (with restrictions). A maintenance demand or above average wear has been determined. The wear tolerance will soon be exhausted or is reducing at a faster rate than expected. Maintenance is necessary in the medium term.

Out of specification

The positioner is operated outside specified operating conditions.

Maintenance alarm

The positioner cannot perform its control task due to a functional fault in the positioner itself or in one of its peripherals

or an initialization has not yet been successfully completed.

FOUNDATION™ fieldbus communication

In Type 3730-5 and Type 3731-5, single messages can be classified with a further status for the block error (BLOCK_ERR). Refer to the standard instructions of the Type 3730-5 or Type 3731-5 Positioners.

2.3 Logging

The last thirty messages are saved in the positioner with a time-stamp (logged by the operating hours counter).

You can view these messages in TROVIS-VIEW3 in the *Diagnosis* folder (> *Status messages* > *Logger*).

Note: *If the positioner is fitted with a solenoid valve, a triggering of the solenoid valve can only be logged when the logging of int. solenoid valve is activated.*

In the event the solenoid valve is triggered again, this is only logged when the Min. clearance new logging int. solenoid valve has elapsed since the last triggering.

Positioner – Error control

- Logging of int. solenoid valve: [Yes], No
- Min. clearance new logging int. solenoid valve: 0 to 5000 s, [300 s]

2.3.1 Resetting status messages and diagnosis data

When a status message is generated, you should first locate the source of the fault and take action to remedy it.

In case of a standard status message, read the recommended action on how to remedy these faults in the standard instructions.

Section 9 (page 57) contains recommended action for extended status messages which the positioner generated from *Statistical information* (in-service monitoring) and *Tests* (out-of-service diagnostics).

Note: Table 7 contains a list of the various resetting functions of the positioner. In the event that measured data and diagnostic alarms remain even after resetting the positioner, it is possible to upload them onto a computer using a software program, e.g. TROVIS-VIEW3.

Resetting single status messages

► Standard status messages

Reset individual status messages in the *Diagnosis* folder (> *Status messages* > *Reset*).

Note: Status messages represented by a code in the positioner can be confirmed at the positioner itself. Select the error code and confirm it by pushing the rotary pushbutton.

► Extended status messages generated from *Statistical information* (in-service monitoring) and *Tests* (out-of-service diagnostics)

Extended status messages are based on the diagnosis measured data. If an extended status message is active, you can read it at the positioner regardless of its classification by selecting Code 79.

Select *Diagnosis* folder (> *Status messages* > *Reset*) to reset individual status messages.

Note: On resetting histograms and diagrams, the data for short-term monitoring are also reset.

Resetting measured data does not reset the reference graphs.

Resetting the diagnosis

Right-click *Reset diagnosis* and select *Execute* to reset the data of *Statistical Information* and *Tests* as listed in Table 7.

Classified status messages and data logs remain saved.

Operation unit or Positioner – Start-up

– Reset diagnosis (Code 36 - Diag)

It is possible to perform one reset after the time entered in *Required time* 'Reset diagnosis' has elapsed.

If this option is activated, the remaining time until the reset is shown (Code 48 - h4).

Diagnosis – Status messages – Reset

- Required time 'Reset diagnosis' (Code 48 - h3): [00:00:00 d.h:min:sec]

Starting with default settings

Activate *Reset with default values* to reset the positioner parameters to their default settings (see code list in standard instructions).

Measured data and any analysis of valve diagnostic data are also reset.

**Operation unit or
Positioner – Start-up**

- Reset with default values (Code 36 - Std)

Mounting the positioner onto another control valve

After mounting the positioner on a new control valve, perform a reset by activating *Reset with default values* (Code 36, Std) to reset and re-initialize the positioner.

Function		Resetting single messages	Resetting diagnosis	Reset with default values
Operating hours counter				
Device switched on since last initialization		—	•	•
Device in closed loop since initialization		—	•	•
Status classification		—	—	•
Logging		•	—	•
Statistical information (in-service monitoring)				
Open/Close (not Type 3730-4)	Parameters	•	—	•
	Measured data	•	•	•
Data logger		—	•	•
Travel histogram		•	•	•
Short-term monitoring		•	•	•
Setpoint deviation histogram		•	•	•
Short-term monitoring		•	•	•
Cycle counter histogram		•	•	•
Short-term monitoring		•	•	•
Drive signal histogram (steady-state)		•	•	•
Short-term monitoring		•	•	•
Drive signal histogram (hysteresis) (d5)		•	•	•
Short-term monitoring		•	•	•
End position trend	Reference value	•	•	•
	Parameters, measured data	•	•	•
Tests (out-of-service diagnostics)				
Drive signal diagram (steady-state) (d1)	Reference values	—	—	•
	Measured data	•	•	•
Drive signal diagram (hysteresis) (d2)	Reference values	—	—	•
	Measured data	•	•	•
Static characteristic (d3)		—	•	•
Partial stroke test - PST (d4)		•	—	•
Full stroke test (d6)		•	—	•
All adjusted parameters and any measured data of the listed diagnostic functions are reset, if not stated otherwise				
Table 7 · Resetting functions				

3 Statistical information

The positioner records the reference variable w , valve position x , and drive signal y even while the process is running to obtain information also over the valve, actuator and pneumatic air supply. The data compiled while the process is running are saved and analyzed by the monitoring functions in statistical information. In addition, an additional underlaid hysteresis test can detect any changes in friction.

The monitoring functions of statistical information do not have any affect on the running process.

The measured data are analyzed after the positioner has been in the **AUTO** mode or in **MAN** mode for an hour. However, the analysis for the *Cycle counter histogram* and *End position trend* start directly after the positioner changes to the **AUTO** mode or **MAN** mode.

3.1 Open/close

Note: The diagnosis for open/close (on/off) valves is not available for Type 3730-4.

Fig. 4

The monitoring of open/close (on/off) valves provides statements on the valve end positions, transit times (rising/falling) and breakaway times (rising/falling).

Starting open/close monitoring

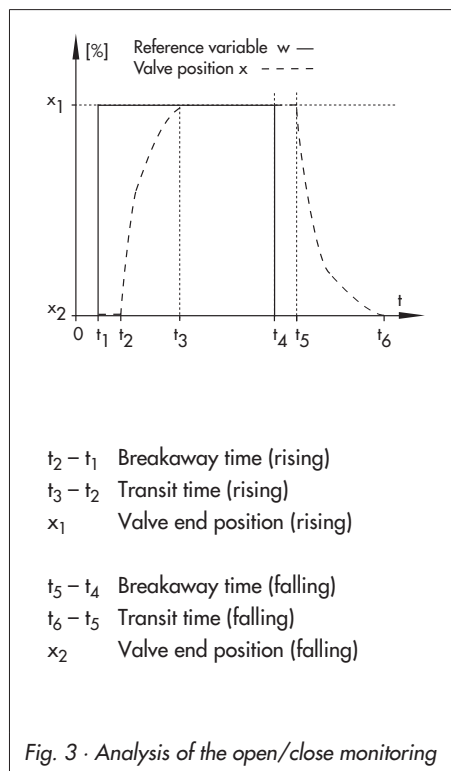
The open/close monitoring runs for open/close valves in **AUTO** mode in the

background. The monitoring does not need to be activated.

While the plant is running, *Breakaway time* (rising/falling), *Transit time* (rising/falling) and *Valve end position* parameters are recorded.

The first values recorded are used as a reference for further tests.

The analysis pinpoints to an open/close fault whenever at least one of the following conditions is met:



- ▶ The current *Breakaway time (rising/falling)* differs from the reference value by the amount in *Limit value travel analysis*.
- ▶ The current *Transit time (rising/falling)* differs from the reference value by the amount in *Limit value time analysis*.
- ▶ The current travel (difference between *Valve end positions*) differs from the reference value by the amount in *Limit value travel analysis*.

Note: The positioner saves the reference analysis and two further test analyses in a non-volatile memory. The oldest test analysis is then overwritten when a third test is to be saved. The error message generated by the open/close diagnosis is reset as soon as a parameter is changed.

Positioner – Start-up

- Application type (Code 49 - h0): **Open/Close valve**

Diagnosis – Statistical information – Open/Close

- Limit value time analysis (Code 49 - h7): 0.6 to 30.0 s, [0.6 s]
- Limit value travel analysis (Code 49 - h8): 0.1 to 100.0 %, [0.3 %]

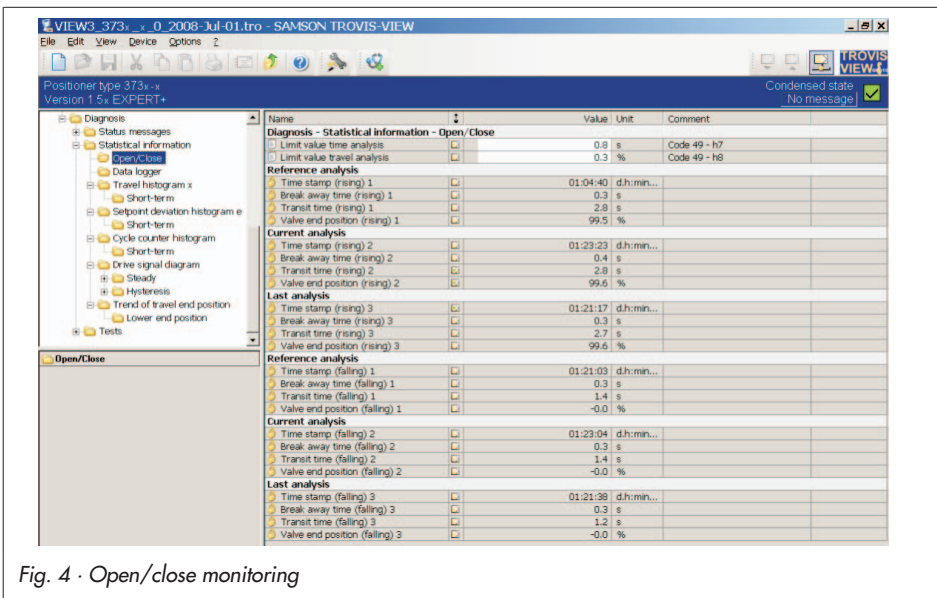


Fig. 4 · Open/close monitoring

3.2 Data logger

Fig. 5

The data logger allows the reference variable w , valve position x (in relation to the operating range), drive signal y and setpoint deviation e to be plotted over time. The last 100 measured data points of each variable are saved in the positioner. The recorded measured data are plotted over time in a graph in TROVIS-VIEW3.

Data are either plotted permanently or automatically triggered when a start condition is fulfilled (see sections 3.2.1 and 3.2.2).

Activating the data logger

Right-click *Start data logger* and select *Execute* to start data logging. It can be activated in all operating modes (**AUTO**, **MAN** and fail-safe position).

Note: On disconnection of the auxiliary power or on changing the operating mode, the data logger is inactive and must be reactivated.

Cancelling the data logger

Right-click *Stop data logger* and select *Execute* to cancel data logging.

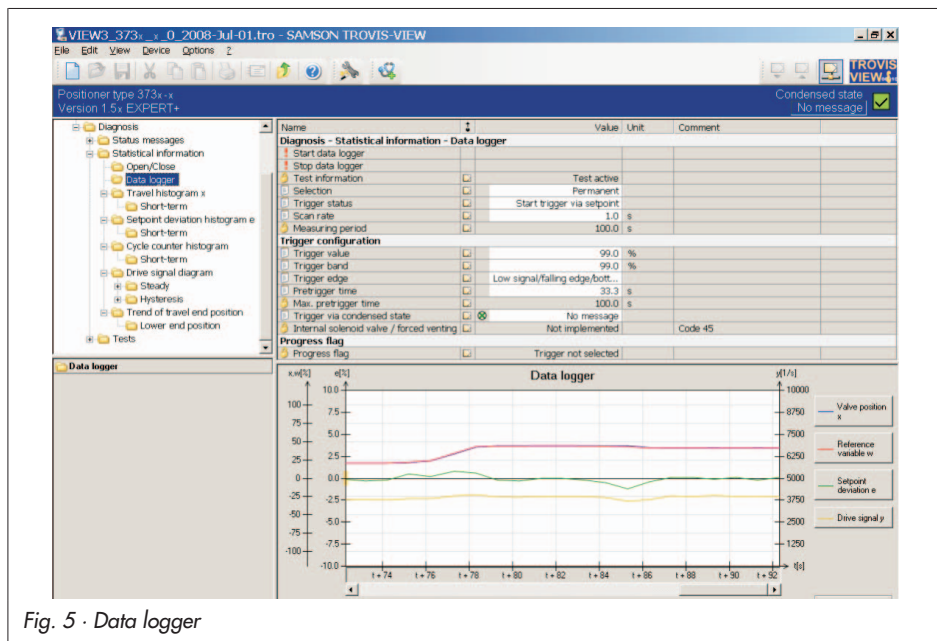


Fig. 5 · Data logger

3.2.1 Permanent data logging

The variables w , x , y , and e are saved in a FIFO memory in the positioner with a memory depth of 100 data points according to the *Scan rate*.

Note: If you keep the TROVIS-VIEW software open with the Diagnosis folder (> Statistical information – Data logger) selected, you can read the data from this graph plotted over the last 24 hours .

Diagnosis – Statistical information – Data logger

- Selection: **Permanent**
- Scan rate: 0.2 to 3600.0 s, [1.0 s]
- Start data logger

3.2.2 Triggered data logging

The data logger records the variables w , x , y , and e permanently in the background according to the *Scan rate*. The occurrence of a triggering event leads to the measured data points being saved and to the logging of the condition that triggered the event.

A *Pretrigger time* greater than 0 also leads to the measured data which were recorded before the triggering event being saved for the selected time.

The data logging finishes automatically as soon as the maximum memory capacity of 100 measured data points for each variable including the pretrigger time is reached. The *Progress flag* indicates in this case “Memory full. Data logging completed”.

Start trigger via internal solenoid valve/forced venting

The triggering event starts as soon as the integrated solenoid valve is activated or the forced venting becomes active.

Note: This function can only be activated if the positioner is fitted with a solenoid valve/forced venting. See reading in Internal solenoid valve/forced venting (Code 45).

Diagnosis – Statistical information – Data logger

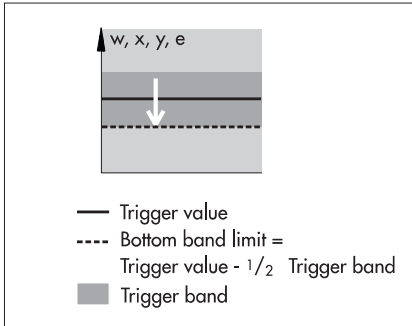
- Selection: **Trigger**
- Trigger status: **Start trigger via int. sol. valve/forced venting**
- Scan rate: 0.2 to 3600.0 s, [1.0 s]
- Pretrigger time ¹⁾: 0.0 s to 100 x *Scan rate*, [33.33 s]
- Start data logger

¹⁾ The *Pretrigger time* may not be higher than *Max. Pretrigger time*.
Max. Pretrigger time = 100 x *Scan rate*

Start trigger via setpoint/valve position/drive signal y/setpoint deviation (single variable)

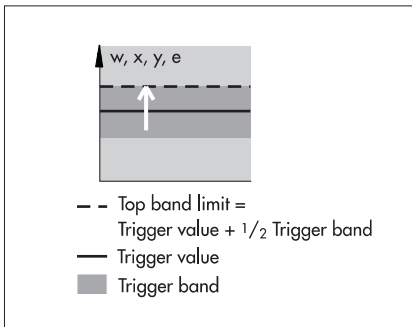
The triggering event starts as soon as the conditions for the selected variable (w , x , y , e) defined in *Trigger value*, *Trigger band* and *Trigger edge* are fulfilled:

- *Trigger edge* = Low signal/falling edge/bottom band exit



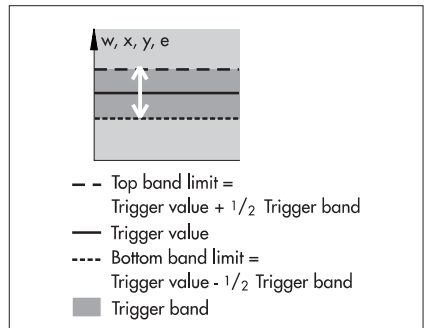
The triggering event starts as soon as the selected variable (w, x, y, e) moves out of the trigger band and passes through the bottom band limit.

- *Trigger edge* = High signal/rising edge/top band exit



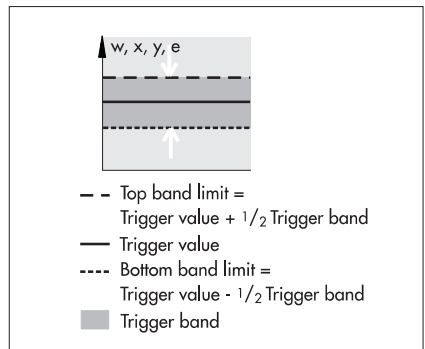
The triggering event starts as soon as the selected variable (w, x, y, e) moves out of the trigger band and passes through the top band limit.

- *Trigger edge* = Band exit



Triggering starts when the variable (w, x, y, e) leaves the trigger band. This function is only active when *Trigger band* is not equal 0.

- *Trigger edge* = Band entry



Triggering starts when the variable (w, x, y, e) enters the trigger band. This function is only active when *Trigger band* is not equal 0.

Note: The bottom band limit takes on the value 0.0 % (variable w , x , e) or 0.0 ‰ (variable y) at the minimum. The top band limit takes on the value 100.0 % (variable w , x , e) or 10000 ‰ (variable y) at the maximum.

Diagnosis – Statistical information – Data logger

- Selection: **Trigger**
- Trigger status: **Start trigger via setpoint (w)/ valve position (x)/setpoint deviation (e)/ drive signal (y)**
- Scan rate: 0.2 to 3600.0 s, [1.0 s]
- Trigger value:
0.0 to 100.0 %, [99.0 %] (w , x , e)
0.0 to 10000 ‰, [99 ‰] (y)
- Trigger band:
0.0 to 100.0 %, [99.0 %] (w , x , e)
0.0 to 10000 ‰, [99 ‰] (y)
- Pretrigger time ¹⁾: 0.0 s to 100 x Scan rate, [33.33 s]
- Trigger edge: [Low signal/falling edge/ bottom band exit], High signal/rising edge/ top band exit, Band exit, Band entry
- Start data logger

¹⁾ The *Pretrigger time* may not be higher than *Max. Pretrigger time*.
Max. Pretrigger time = 100 x Scan rate

Start trigger via setpoint/internal solenoid valve/forced venting

The triggering event starts as soon as one of the conditions “Start trigger via setpoint” or “Start trigger via internal solenoid valve/forced venting” is fulfilled.

Diagnosis – Statistical information – Data logger

- Selection: **Trigger**
- Trigger status: **Start trigger via setpoint/ int. sol. valve/forced vent.**
- Scan rate: 0.2 to 3600.0 s, [1.0 s]
- Trigger value: 0.0 to 100.0 %, [99.0 %]
- Trigger band: 0.0 to 100.0 %, [99.0 %]
- Pretrigger time ¹⁾: 0.0 s to 100 x Scan rate, [33.33 s]
- Trigger edge: [Low signal/falling edge/ bottom band exit], High signal/rising edge/ top band exit, Band exit, Band entry
- Start data logger

¹⁾ The *Pretrigger time* may not be higher than *Max. Pretrigger time*.
Max. Pretrigger time = 100 x Scan rate

Start trigger via condensed state

The triggering event starts as soon as the condensed state defined in *Start trigger via condensed state* arises.

Diagnosis – Statistical information – Data logger

- Selection: **Trigger**
- Trigger status: **Start trigger via condensed state**
- Scan rate: 0.2 to 3600.0 s, [1.0 s]
- Pretrigger time ¹⁾: 0.0 s to 100 x Scan rate, [33.33 s]
- Trigger via condensed state: No message, [Maintenance required], Maintenance demanded, Out of specification, Maintenance alarm
- Start data logger

¹⁾ The *Pretrigger time* may not be higher than *Max. Pretrigger time*.
Max. Pretrigger time = 100 x Scan rate

Start trigger via binary input

The triggering event starts as soon as the state of the binary input changes.

Diagnosis – Statistical information – Data logger

- Selection: **Trigger**
- Trigger status: **Trigger via binary input**
- Scan rate: 0.2 to 3600.0 s, [1.0 s]
- Pretrigger time ¹⁾: 0.0 s to 100 x Scan rate, [33.33 s]
- Start data logger

¹⁾ The *Pretrigger time* may not be higher than *Max. Pretrigger time*.
Max. Pretrigger time = 100 x Scan rate

3.3 Travel histogram

Fig. 6

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

The positioner generates a message if the analysis of the travel histogram detects an error in “Shifting working range” or “Working range”.

Activating the data recording

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

Long-term monitoring

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

The *Average value x long* indicates the average class assignment over the *Observation period*. The *Number of measurement values* shows the total amount of recorded classified valve positions.

The measured data for long-term monitoring are stored every 24 hours in the positioner's non-volatile memory.

3.3.1 Short-term monitoring

In order to be able to recognize any short-term changes in valve position, the positioner records the valve positions according to the adjusted *Scan rate short-term histogram*.

The positioner saves the measured data in a FIFO memory with a memory depth of 100 measured data points. The last 100 measured data points are saved in the *Short-term* folder.

The *Average values x short* contains the average class assignment for the last 100 measured data points.

Note: On changing the Scan rate short-term histogram, old data in the Short-term folder are deleted.

Diagnosis – Statistical information – Travel histogram x – Short-term

- Scan rate short-term histogram:
1 to 3600 s, [1 s]

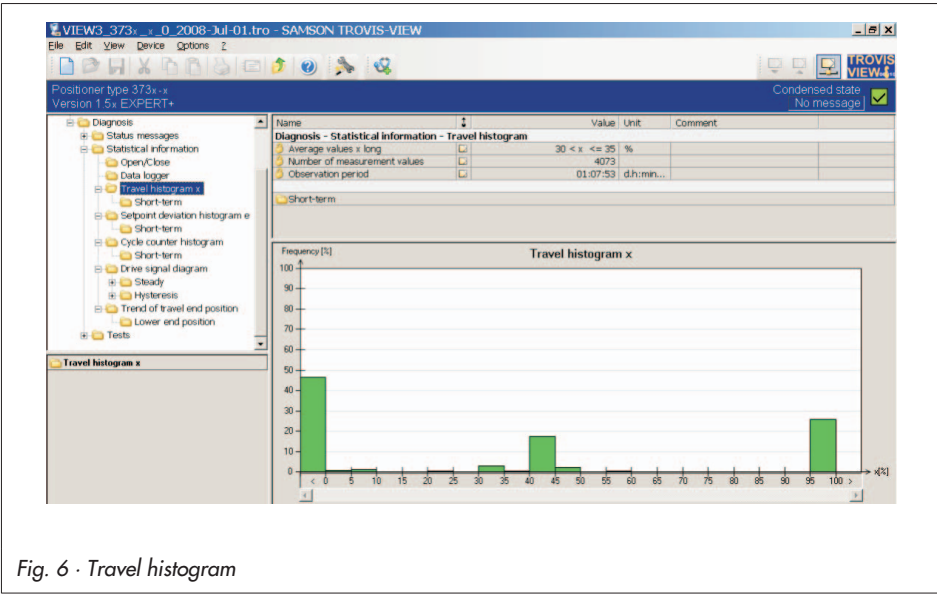


Fig. 6 · Travel histogram

3.4 Setpoint deviation histogram

Fig. 7

The setpoint deviation histogram contains a statistical analysis of any setpoint deviations recorded. This provides a summary of how often and to which level a setpoint deviation has occurred during the valve service life and whether it shows a recent trend concerning the setpoint deviation.

Ideally, the setpoint deviation should be as small as possible.

The positioner generates a message if the histogram detects an error in "Limiting working range", "Inner leakage" or "Connection positioner/valve".

Activating the data recording

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

Long-term monitoring

For long-term monitoring, the positioner records the setpoint deviation every second and assigns the data into predefined classes. The distribution showing how often the setpoint deviation remained within a class is shown in a bar graph.

The *Average value e long* indicates the average class assignment over the *Observation period*. The *Number of measurement values* shows the total amount of recorded classified setpoint deviations.

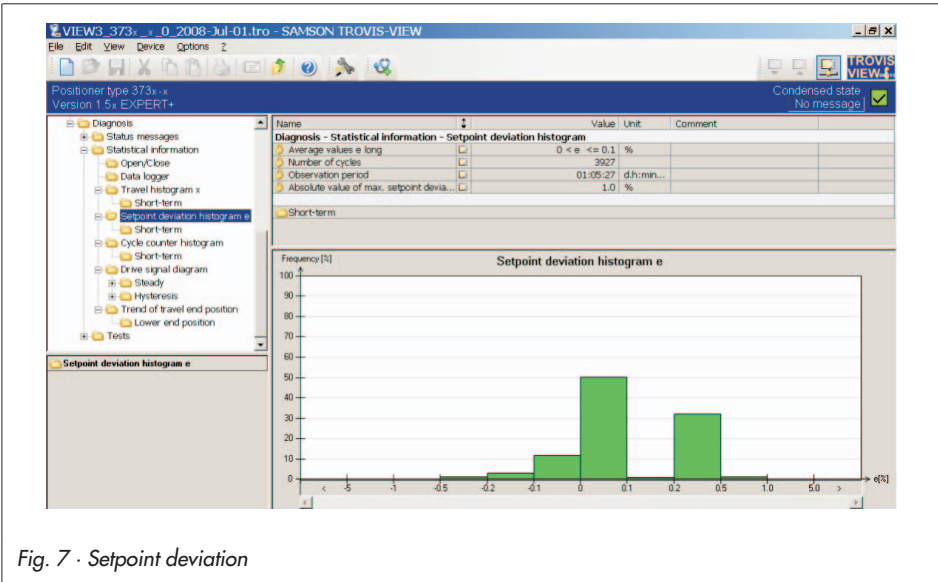


Fig. 7 · Setpoint deviation

The largest setpoint deviation measured over *Observation period* is specified in *Absolute value of max. setpoint deviation*.

The measured data for long-term monitoring are stored every 24 hours in the positioner's non-volatile memory.

3.4.1 Short-term monitoring

In order to be able to recognize any short-term changes in setpoint deviation, the positioner records the setpoint deviations according to the adjusted *Scan rate short-term histogram*.

The positioner saves the measured data in a FIFO memory with a memory depth of 100 measured data points. The last 100 measured data points are saved in the *Short-term* folder.

The *Average values e short* contains the average class assignment for the last 100 measured data points.

Note: On changing the *Scan rate short-term histogram*, old data in the *Short-term* folder are deleted.

Diagnosis – Statistical information – Setpoint deviation histogram – Short-term

- Scan rate short-term histogram:
1 to 3600 s, [1 s]

3.5 Cycle counter histogram

Fig. 8

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

Note: A valve cycle starts at the point where the valve stroke changes direction until the point where it changes direction again. The valve stroke between these two changes in direction is the cycle span.

The *Dynamic stress factor* is specified as a percentage reflecting the stress of the packing and/or bellows. The error message "External leakage – Maybe to be expected soon" is generated if the dynamic stress factor exceeds 90 %.

Activating the data recording

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

Long-term monitoring

The positioner records the number of cycles and the cycle spans for the long-term monitoring. The cycle spans are assigned to cycle classes. The calculated percentages on how often a cycle occurs within a class are shown as a bar graph.

The *Average value z long* contains the average cycle class for the *Number of measurement values*.

Note: The Dynamic stress factor is determined from the cycle span and how often the cycle spans occurred (frequency) depending on which packing has been selected. To ensure this factor is correctly determined, make sure the correct packing is selected in the Stuffing box parameter in the Identification folder (> Positioner > Valve). If "Other" is selected for the Stuffing box parameter, the number of cycles to determine the dynamic stress factor is limited to the value entered in Max. cycle counter limit (default: 1000000). See section 1.4.

The measured data for long-term monitoring are stored every 24 hours in the positioner's non-volatile memory.

3.5.1 Short-term monitoring

Short-term monitoring allows any short-term changes in cycle spans to be recognized.

The positioner saves the measured data in a FIFO memory with a memory depth of 100 measured data points. The last 100 measured data points are saved in the Short-term folder.

The Average value z short indicates the average cycle class for the last 100 measured data points.

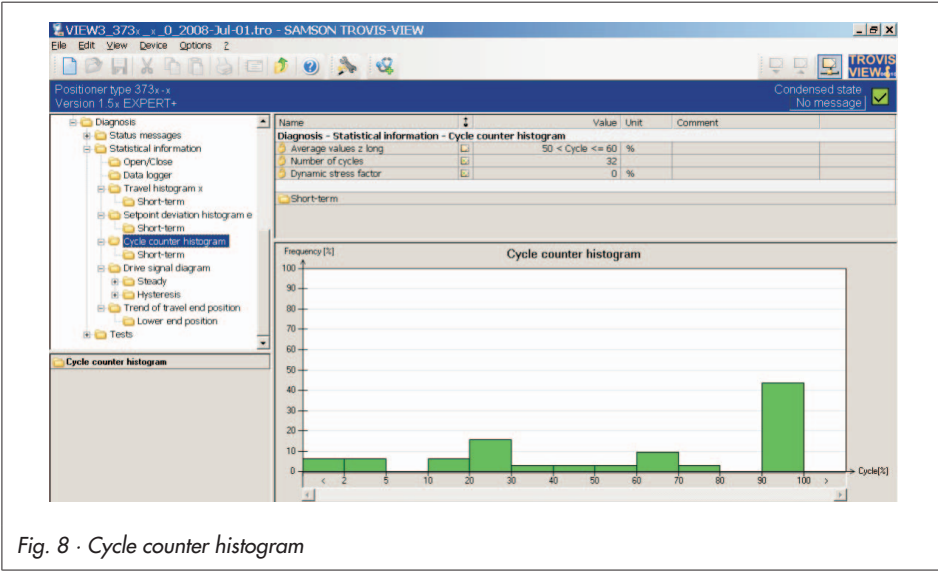


Fig. 8 · Cycle counter histogram

3.6 Steady-state drive signal diagram

Fig. 9

Steady-state drive signal diagram allows changes in the supply pressure or leakage in the pneumatics to be detected.

Note: The drive signal y is based on the internal control signal of the i/p converter. This signal runs directly proportional to the signal pressure in the pneumatic actuator, in relation to the valve position.

If the supply pressure is insufficient for the actuator to move through the entire bench range, this pinpoints to a fault in supply

pressure or leakage in pneumatics. In this case, the positioner generates a message.

Activating the data recording

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

Note: For the Drive signal diagram steady-state in Statistical information, the reference data for Drive signal diagram steady-state (d1) in Tests needs to be recorded. Refer to section 1.4. Read section 1.5 about restrictions.

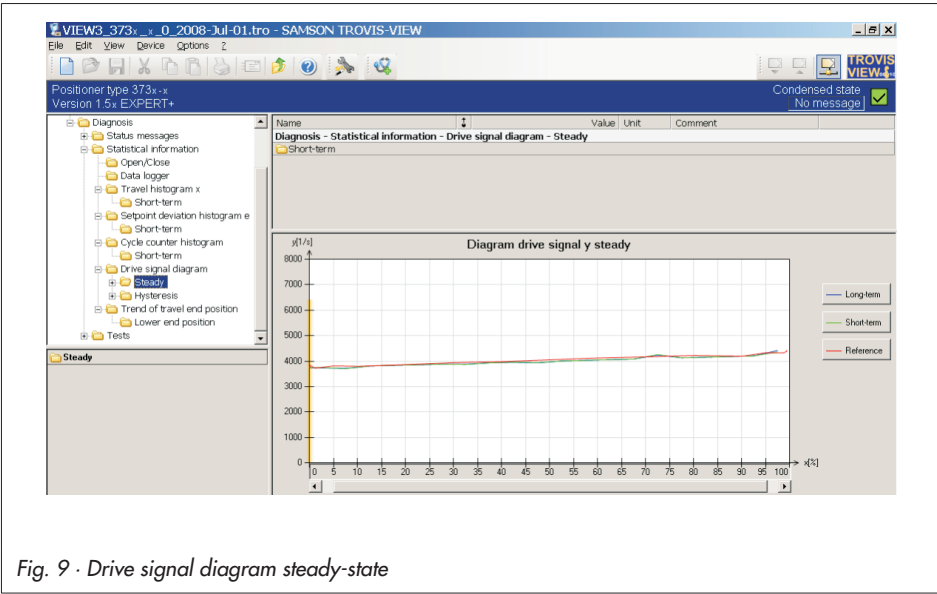


Fig. 9 · Drive signal diagram steady-state

Long-term monitoring

The positioner records the valve position x and its associated drive signal y in closed-loop operation after the pressure conditions have settled (steady-state) for long-term monitoring. Each pair of measured data points recorded is assigned to a valve position class. The average drive signal is calculated for each class. The stored data can be read out. The drive signal y is plotted in a graph against the valve position x .

Reference values are used in cases where no data could be compiled for valve positions x as the valve did not move to those positions or a steady-state could not be reached.

Note: Data are not recorded if Enable setpoint cutoff decrease (*tight-closing function, Code 14*) is active and the valve moves to the value entered in Setpoint cutoff decrease.

Test analysis

The following effects can be read from comparing the correlation between the drive signal and valve position measured during operation and the reference graph:

- ▶ The drive signal measured with a pressure drop across the valve while the process is running drops below the reference while the gradient rises regardless of the valve.
- ▶ The drive signal starts to rise steadily at a certain valve opening compared to the reference graph. This pinpoints to significant leakage in the pneumatics arising due to screw fittings that are not tight-

ened properly or due to a tear in the diaphragm.

- ▶ The drive signal initially follows the reference graph and then starts to rise almost steadily. This pinpoints to the supply pressure being insufficient for the valve to move over its entire working range.
- ▶ The drive signal shifts downwards with an ever smaller gradient compared to the reference graph, pinpointing to a reduced spring force in a control valve with the fail-safe position "Fail-to-close".

3.6.1 Short-term monitoring

In order to be able to recognize any short-term changes in the actuator pressure at various valve positions, the average drive signal y is determined from the last measured data points for each valve position class.

The positioner saves the drive signal y and the valve position x in a FIFO memory with a memory depth of ten measured data points. The last ten recorded data points of each variable are listed in the *Drive signal y* folder and the *Valve position x* folder.

Note: If the process allows a Test function (*out-of-service diagnostics*) to be performed, the results from the Statistical information function can be checked with a test. Refer to section 4.1.

3.7 Drive signal diagram - Hysteresis test (d5)

Fig. 10

The hysteresis test allows changes in friction to be analyzed.

The positioner generates a message when the results of the hysteresis test pinpoint to "Friction" or "External leakage".


Activating the hysteresis test

Activate the hysteresis test in **AUTO** or **MAN** operating mode by right-clicking *Start test* and select *Execute*.

Enable time distance specifies whether the test is to be performed once (immediately) or cyclically. If the test is to be performed cycli-

cally, *Min. time distance from test* determines the interval between tests.

Note: If you start the test in MAN mode with the Enable time distance = User-defined and another test is active when the hysteresis test is to start, the hysteresis test is started after a delay of 30 seconds after the active test has been completed.

An active test is indicated by **test** and **d5** and  appearing in alternating sequence on the positioner display.

Note: A reference graph must be plotted in Drive signal diagram hysteresis in Tests (out-of-service diagnostics) for the Drive signal diagram hysteresis (d5) in Statistical in-

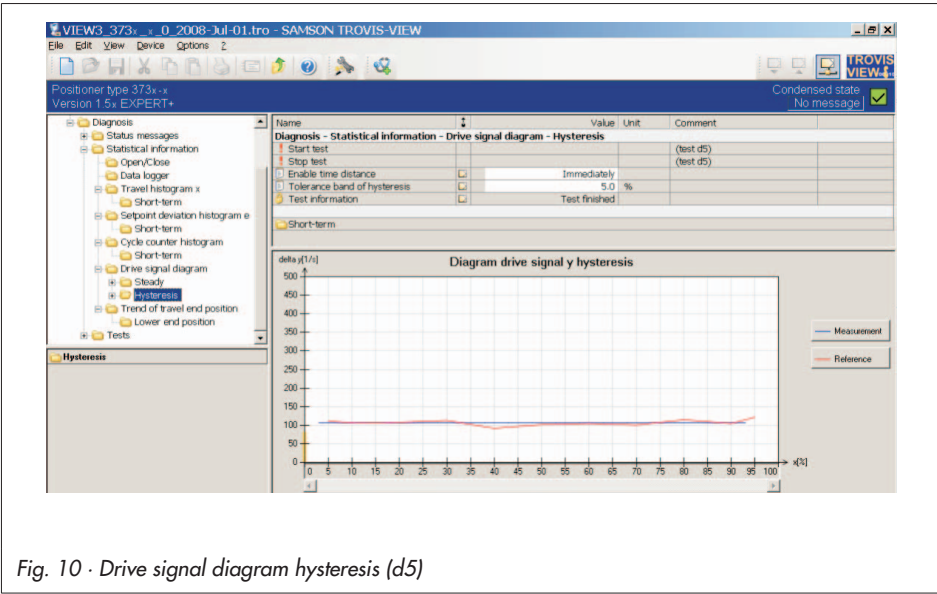


Fig. 10 · Drive signal diagram hysteresis (d5)

formation (*in-service monitoring*). Refer to section 1.4.

Read section 1.5 about the restrictions!

Cancelling the hysteresis test

Right-click *Stop test* and select *Execute* or press the rotary pushbutton on the positioner to cancel the hysteresis test.

Long-term monitoring

Based on an operating point, the test is performed with a change in travel $< 1\%$ to find the change in drive signal (Δy).

Note: *If the hysteresis test is not completed because the valve position is at the top or bottom limit of the working range, the positioner generates the message (Test information) "Test not possible in operating point".*

The changes in drive signal Δy are classified according to the valve position x in the valve position classes. The average value Δy per valve position class is determined from all the measured data and plotted in the graph (Measurement).

The data for long-term monitoring do not necessarily cover the full working range of the valve. In this case, these are represented by a line of the reference data.

Tolerance band of hysteresis monitors the test:

- ▶ If the valve position x leaves the *Tolerance band of hysteresis* during the test, the test is immediately cancelled and the

positioner returns to closed-loop operation.

- ▶ If a change in the reference variable (Δw) occurs which is greater than the *Tolerance band of hysteresis*, the test is immediately cancelled and the test is started again after waiting 30 seconds using the new operating point. The test is started again ten times at the maximum. The time between tests is increased by 30 seconds each time (30 s x Number of tests repeated). After the test is cancelled for the tenth time (due to Δw), the time entered in *Minimum time distance from test* is kept again.

The following parameters are changed correspondingly during the hysteresis test:

- ▶ Travel/angle range start (Code 8) → 0 %
- ▶ Travel/angle range end (Code 9) → 100 %
- ▶ Enable travel/angle lower limit (Code 10) → OFF
- ▶ Enable travel/angle upper limit (Code 11) → OFF
- ▶ Enable setpoint cutoff decrease (Code 14) → OFF
- ▶ Enable setpoint cutoff increase (Code 15) → OFF
- ▶ Required transit time OPEN (Code 21) → Variable
- ▶ Required transit time CLOSED (Code 22) → Variable

Diagnosis – Statistical information – Drive signal diagram – Hysteresis

- Enable time distance: [User defined], Immediately
- Min. time distance from test: 1.0 to 24.0 h, [1.0 h]
- Tolerance band of hysteresis: 1.0 to 5.0 %, [1.0 %]

3.8 Trend of travel end position

Fig. 11

This *Statistical information* function is used to detect a fluctuating zero point or a creeping zero point shift due to seat and plug wear or dirt between the seat and plug.

The positioner generates a message when the results of the end position trend detect an error in "Observing end position".

Activating the data recording

Data are recorded in the background in both **AUTO** and **MAN** operating mode. It does not need to be activated.

Data are only recorded if the tight-closing function is active (*Enable setpoint cutoff decrease*).

Note: A reference zero point is needed to analyze the test. This is recorded during the reference test. In case a reference test has not been performed, the first zero point that the valve moved to serves as the reference.

Test description

The end position trend records the valve position x and the drive signal y with a time stamp by the operating hours counter when the valve moves to the lower end position. The new recorded valve position x is compared to the last value (the first measured data point with the reference value). If it differs by the *Threshold value for data recording* from the reference value, the data of the new zero point are saved.

3.7.1 Short-term monitoring

To provide a short-term trend, the last ten valve positions x and the associated Δy values are saved in a table in the *Short-term* folder (> *Valve position x* and *Difference signal drive*).

Note: If the process allows a Test function (out-of-service diagnostics) to be performed, the results from the Statistical information function can be checked with a test. Refer to section 4.2.

A graph of the recorded end positions is plotted.

The reference value is represented by a straight line in the graph. The graph highlights a trend and a change in the end position.

The last 30 measured data points are saved in the FIFO memory of the positioner. The *Lower end position* folder contains a table of the measured data.

Diagnosis – Statistical information – Trend of travel end position

- Threshold value for data recording: 0.10 to 5.00 %, [0.25 %]

Positioner – Reference variable

- Enable setpoint cutoff decrease (Code 14): [On]
- Setpoint cutoff decrease (Code 14): 0.0 to 49.9 %, [1.0 %]

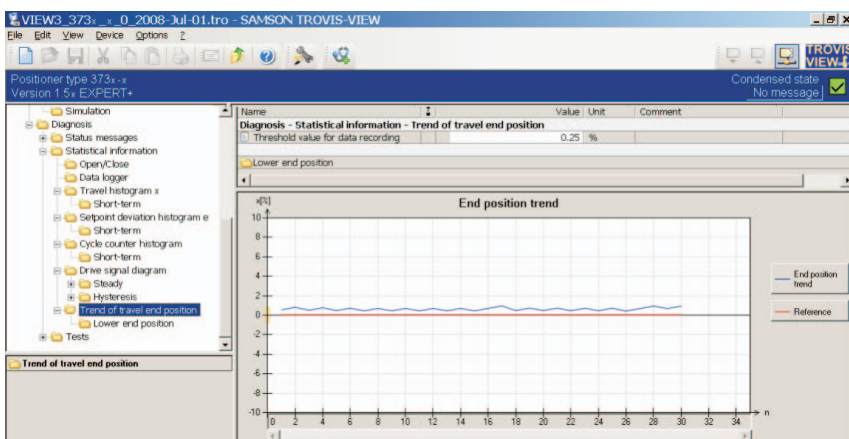


Fig. 11 · Trend of travel end position

4 Tests d1 to d3

For reasons of safety, the tests (out-of-service diagnostics) can only be started when the positioner is in the manual operating mode (**MAN**).

NOTICE

The control valve moves through its defined working range after a test starts. Therefore, it is important to make sure before starting a test whether the conditions (in the plant or process) allow the valve to move.

The *Tests* provide a trend showing the current control valve state, any possible existing malfunctions and help to pinpoint faults and to schedule predictive maintenance work.

The following list of parameters are briefly changed while the tests are running:

- ▶ Travel/angle range start (Code 8) → 0 %
- ▶ Travel/angle range end (Code 9) → 100 %
- ▶ Enable travel/angle lower limit (Code 10) → Off
- ▶ Enable travel/angle upper limit (Code 11) → Off
- ▶ Enable setpoint cutoff decrease (Code 14) → Off
- ▶ Enable setpoint cutoff increase (Code 15) → Off
- ▶ Characteristic selection (Code 20) → Linear
- ▶ Required transit time OPEN (Code 21) → Variable
- ▶ Required transit time CLOSED (Code 22) → Variable

4.1 Drive signal diagram steady-state (d1)

Fig. 12

The drive signal diagram steady-state allows you to check the results of the steady-state drive signal diagram in *Statistical information* (in-service monitoring) more closely (see section 3.6).

The positioner generates a message marked "(TEST)" if the analysis of the drive signal pinpoints to a fault in supply pressure, air leakage in the pneumatics or actuator springs.

Starting the test

Right-click *Start test* and select *Execute* when the positioner is in the manual operating mode (**MAN**).

While the test is active, **d1** and **test** appear on the positioner display in alternating sequence.

Note: Reference data are needed to analyze the test. See section 1.4.

In cases where the positioner does not have any reference data available, the data from the first test are used as the reference. Read section 1.5 about restrictions.

Cancelling the test

Cancel the test by right-clicking *Stop test* and selecting *Execute* or by pressing the rotary pushbutton at the positioner. After the test has been cancelled, the positioner changes back to the manual operating mode (**MAN**).

Test description

After starting the test, the valve moves to various fixed valve positions x distributed over the working range of the valve. The drive signal y is measured for each valve position x and compared with the reference graph.

The recorded data of the drive signal y are plotted versus the valve position x in a graph (Repetition).

Note: Every time the test is performed, old measured data are overwritten (Repetition).

Diagnosis – Tests – Drive signal diagram steady

– Start test

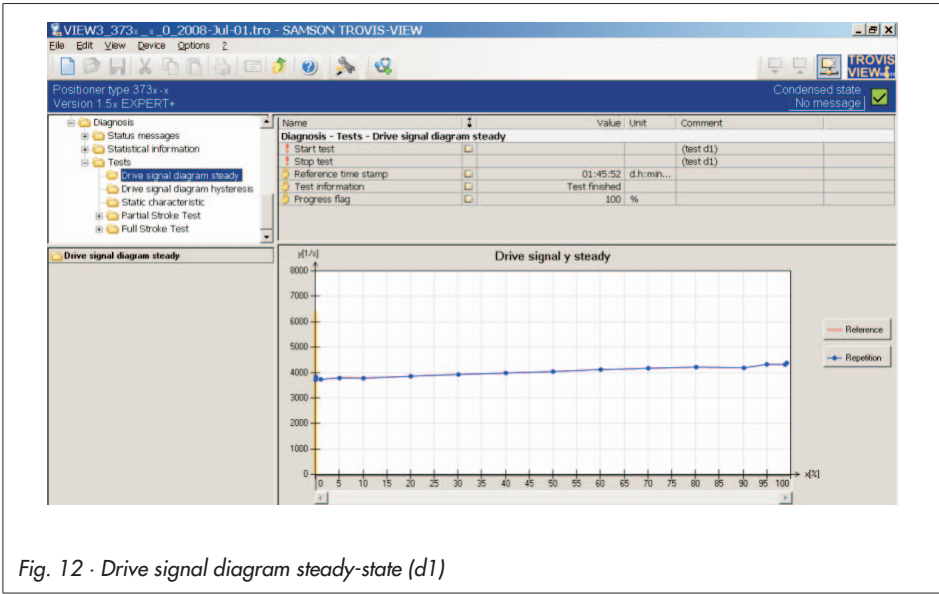


Fig. 12 · Drive signal diagram steady-state (d1)

4.2 Drive signal diagram hysteresis (d2)

Fig. 13

This test allows you to check the results of the drive signal diagram (hysteresis test) in *Statistical information* (in-service monitoring) more closely (section 3.7).

The positioner generates a message marked "TEST" if the analysis of the hysteresis test indicates friction or external leakage.

Starting the test

Right-click *Start test* and select *Execute* when the positioner is in the manual operating mode (**MAN**).

While the test is active, **d2** and **test** appear on the positioner display in alternating sequence.

Note: Reference data are needed to analyze the test. See section 1.4.

In cases where the positioner does not have any reference data available, the data from the first test are used as the reference. Read section 1.5 about restrictions.

Cancelling the test

Cancel the test by right-clicking *Stop test* and select *Execute* or by pressing the rotary pushbutton at the positioner.

After the test has been cancelled, the positioner changes back to the manual operating mode (**MAN**).

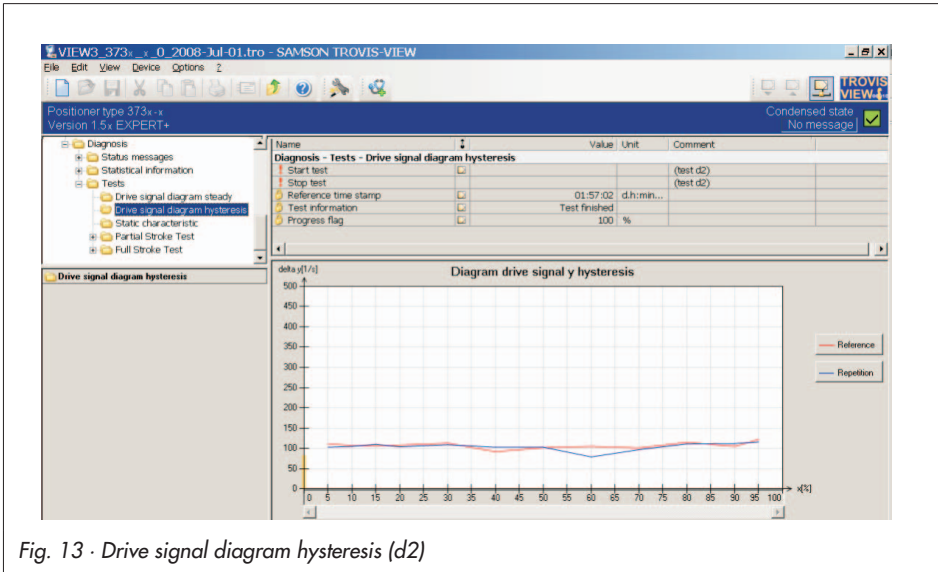


Fig. 13 · Drive signal diagram hysteresis (d2)

Test description

After starting the test, the valve moves to various fixed valve positions *x* distributed over the working range of the valve. After moving to the valve position, a ramp movement changing the valve travel < 1 % is performed. The change in drive signal *y* is measured for each valve position *x* and compared with the reference data.

The recorded data of the change in drive signal are plotted versus the valve position *x* in a graph.

The test is automatically cancelled if the valve cannot move to a certain position or a valve leaves the *Tolerance band of hysteresis*.

Diagnosis – Statistical information – Drive signal diagram – Hysteresis
– Tolerance band of hysteresis (Code 19): 0.1 to 10.0 %, [5.0 %]
Diagnosis – Test – Drive signal diagram – Hysteresis
– Start test

4.3 Static characteristic (d3)

Fig. 14

The static performance of the control valve is affected by the friction hysteresis and the elastic processes in the valve stem packing.

Starting the test

Right-click *Start test* and select *Execute* when the positioner is in the manual operating mode (**MAN**).

While the test is active, **d3** and **test** appear on the positioner display in alternating sequence.

Cancelling the test

Cancel the test by right-clicking *Stop test* and select *Execute* or by pressing the rotary pushbutton at the positioner.

After the test has been cancelled, the positioner changes back to the manual operating mode (**MAN**).

Test description

The positioner specifies the reference variable *w* in a defined test range (*Start* and *End*) in small steps and records the response of the valve position *x* after waiting a defined *Delay time after step*. The step height is determined automatically from the *Number of measurement values until turn back* and the defined test range. The ascendent and descendent are plotted within the test range. The response of the valve position *x* to the change in reference variable is plotted in a graph.

The dead band is analyzed in the positioner when a step height is smaller than 0.2 % (Min. dead band, Max. dead band and Average dead band).

Note: The difference in setpoint that causes a minimal change in the valve position x is termed 'dead band'.

Diagnosis – Tests – Static characteristic

- Start: 0.0 to 100.0 %, [50.0 %]
- End: 0.0 to 100.0 %, [52.0 %]
- Delay time after step: 0.1 to 25.0 s, [1.0 s]
- Number of measurement values until turn back: 1 to 50, [50]
- Start test

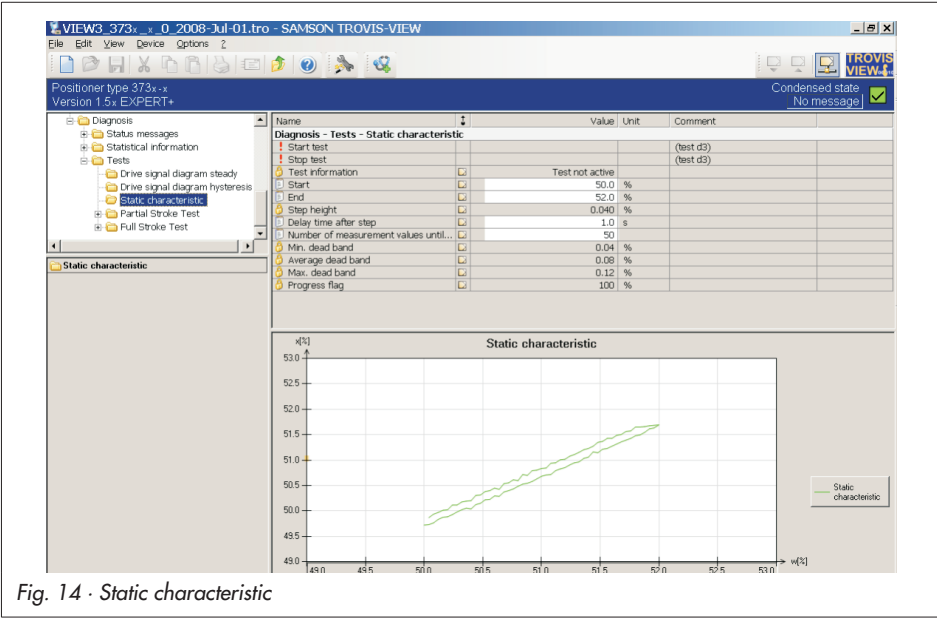


Fig. 14 · Static characteristic

5 Partial stroke test – PST (d4)

Fig. 15

The partial stroke test (PST) is particularly suitable for the status-oriented detection of malfunctions in pneumatic shut-off valves. As a result, the probability of failure on demand (PFD) can be reduced and it may be possible to extend maintenance intervals.

In this way, a valve normally in its end position can be prevented from seizing up or getting jammed.

Recording the test results additionally allows an analysis of the dynamic control response.

If the partial stroke test could not be performed successfully, the positioner generates

a “PST/FST” alarm. Regardless of the status classification, Code 79 is set.

Note: Any partial stroke test performed is logged together with its status, i.e. successful/not successful in the Diagnosis folder (> Status messages > Logger).

The following listed parameters are temporarily changed while the tests are being performed:

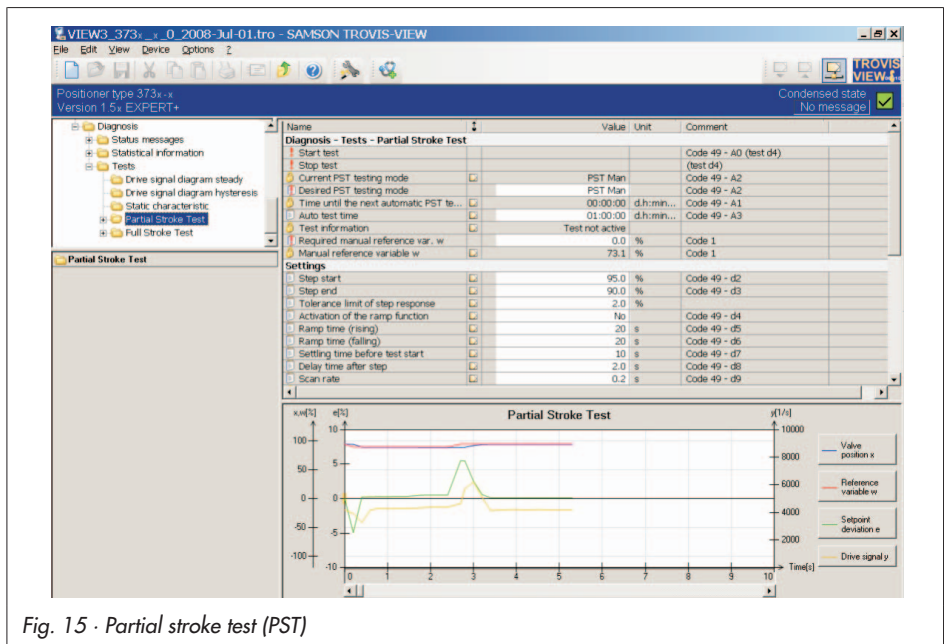


Fig. 15 · Partial stroke test (PST)

- ▶ Characteristic selection (Code 20) → Linear
- ▶ Required transit time OPEN (Code 21) → Variable
- ▶ Required transit time CLOSED (Code 22) → Variable

Starting the partial stroke test

Start the partial stroke test following the details in Table 8.

While the test is running, **d4** and **tEst** appear on the positioner display in alternating sequence.

Note:

*In **PST Auto** mode, you can also start the partial stroke test manually. The countdown of Time until the next automatic PST test takes place is stopped while the manually started test is in progress. Upon failure of the auxiliary power, the automatic activation of the partial stroke test*

remains active. The countdown of Time until the next automatic PST test takes place starts again on restarting the positioner.

The results of the first partial stroke test are used as the reference measurement. Alterations to the parameters listed below cause changes in the test procedure. Therefore, new reference data need to be recorded.

- ▶ Step start (Code 49 - d2)
- ▶ Step end (Code 49 - d3)
- ▶ Activation of the ramp function (Code 49 - d4)
- ▶ Ramp time (rising) (Code 49 - d5)
- ▶ Ramp time (falling) (Code 49 - d6)
- ▶ Delay time after step (Code 49 - d8)

Cancelling the partial stroke test

Cancel the test by right-clicking *Stop test* and select *Execute* or by pressing the rotary pushbutton at the positioner.

Application type	Operat. mode	Test mode PST	Start over binary input	Start test (manually)	Start with auto test time	Start over ref. variable
Control valve	AUTO	PST Man	–	–	–	–
		PST Auto ¹⁾	–	–	–	–
	MAN	PST Man	•	•	–	–
		PST Auto	•	•	•	–
Open/close valve	AUTO	PST Man	•	•	–	•
		PST Auto	•	•	•	•
	MAN	PST Man	•	•	–	–
		PST Auto ¹⁾	–	–	–	–

¹⁾ Setting not possible

Table 8 · Different ways to start the partial stroke test

After the test has been cancelled, the positioner moves the valve to its operating point.

The partial stroke test is automatically stopped when one of the defined cancellation conditions is fulfilled.

After 100 measured values per measured variable have been stored, the logging is stopped. However, the test is still completed. The *Measured data storage out of memory* message is generated by the positioner if the test is not finished when the data logging was stopped.

At the end of the partial stroke test, the test status is directly determined to allow the user to know whether the performed test was completed successfully or not. In case a test has not been completed successfully, the possible reasons for cancellation are specified. The test status and the reasons for cancellation can be read out of the positioner (Code 49) and in the engineering tool used.

Test description

During the partial stroke test, the valve moves from a start value to a defined end value and back to the initial position again. The change in travel can be performed either in steps or in a ramp function (Fig. 16). For the test in a ramp function, additionally the velocities for the rising and falling ramps need to be defined.

Note: The Step start must be in the range of the current operating point \pm Tolerance limit of step response before the partial stroke test can be performed.

After being activated, the test does not start until the *Settling time before test start* (t_1) has elapsed.

Starting from the *Step start* position (pos. 2), the valve moves to the *Step end* position (pos. 3). The valve remains in this position for the time defined by the *Delay time after step* (t_2) before performing a second step change in the opposite direction from the *Step end* position (pos. 3) towards the *Step start* position (pos. 2).

After the *Delay time after step* (t_2) has elapsed, the valve moves back to the operating point (Pos. 1).

The *Scan rate* defines the interval at which the measured values are recorded during the test.

Diagnosis – Tests – Partial Stroke Test

- Step start (Code 49 - d2)¹⁾: 0.0 to 100.0 %, [95.0 %]
- Step end (Code 49 - d3): 0.0 to 100.0 %, [90.0 %]
- Tolerance limit of step response: 0.1 to 10.0 %, [2.0 %]
- Activation of the ramp function (Code 49 - d4): [No], Yes
- Ramp time (rising) (Code 49 - d5)^{2), 3)}: 0 to 9999 s, [15 s]
- Ramp time (falling) (Code 49 - d6)^{2), 3)}: 0 to 9999 s, [15 s]
- Settling time before test start (Code 49 - d7): 1 to 240 s, [10 s]
- Delay time after step (Code 49 - d8): 1.0 to 240.0 s, [2.0 s]
- Scan rate (Code 49 - d9)⁴⁾: 0.2 to 250.0 s, [0.2 s]

- 1) Read Note in Test description
- 2) Parameters are only evaluated if *Activation of the ramp function* is activated (Yes).
- 3) *The Ramp time (falling)/Ramp time (rising)* must be greater than the value determined during initialization for *Minimum transit time OPEN* (Code 40)/*Minimum transit time CLOSED* (Code 41)
- 4) The *Scan rate* must not be lower than the indicated *Min. recommended scan time* (Code 49 - A5). The *Min. recommended scan time* is calculated from the *Duration of the test*.

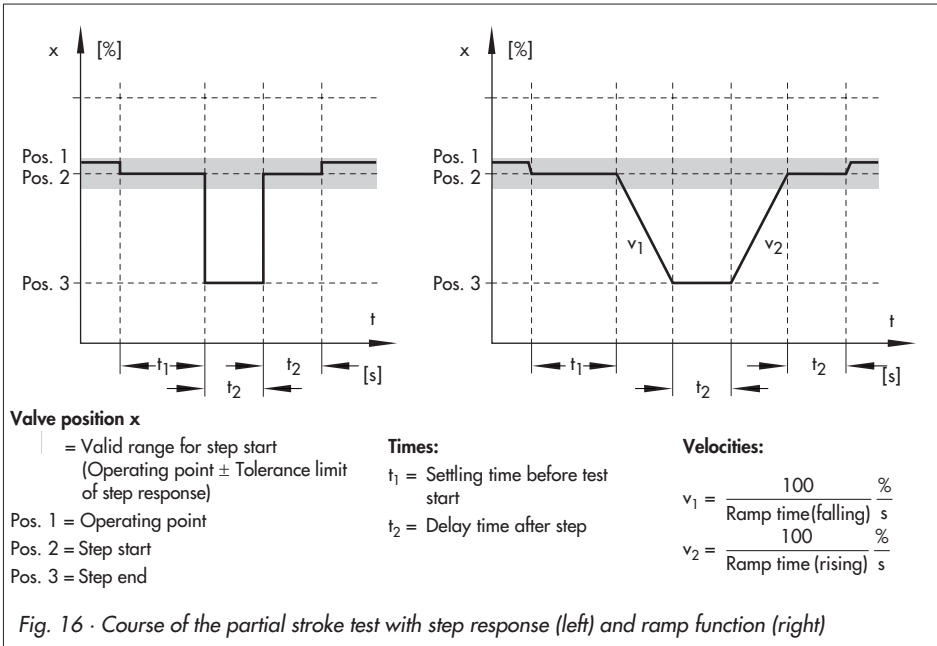
The positioner cancels the partial stroke test when one of the following activated cancellation conditions is fulfilled. The cancellation causes a classified status message to be issued.

Definable cancellation conditions include:

- *Max. test duration*: The test is cancelled when the maximum permissible test duration is exceeded.
- *x control value*: The test is cancelled when the value falls below the adjusted valve position.
The condition is only active when *Activation x control* is set to "Yes".
- *delta y-monitoring*: The test is cancelled when the drive signal y falls below the predetermined comparison value. This comparison value is made up from *delta*

Cancellation conditions

Various cancellation conditions provide additional protection against the valve slamming shut or moving past the end position.



y-monitoring reference value (Code 49 - A7) parameter and the entered safety factor *delta y-monitoring value*.

The *delta y-monitoring value* is entered in % and is based on the entire drive signal range (10 000 $\frac{1}{s}$).

The cancellation condition is active when *Activation delta y-monitoring* is set to "Yes".

- ▶ **PST tolerance band:** The test is cancelled as soon as the deviation of the valve position (in relation to the step final value) exceeds the adjusted PST tolerance band. The condition is only active when *Activation PST tolerance band control* is enabled (= "Yes").

Diagnosis – Tests – Partial Stroke Test

- Max. test duration (Code 49 - E7): 30 to 25000 s, [30 s]
- Activation x control (Code 49 - E0): Yes, [No]
- x control value (Code 49 - E1): -10.0 to 110.0 %, [0.0 %]
- Activation delta y-monitoring ¹⁾ (Code 49 - A8): Yes, [No]
- delta y-monitoring value (Code 49 - A9): 0 to 100 %, [10 %]
- Activation tolerance band control (Code 49 - E5): Yes, [No]
- PST Tolerance band (Code 49 - E6): 0.1 to 100.0 %, [5.0 %]

¹⁾ It only make sense to activate the delta-y monitoring when the partial stroke test is performed as a ramp function. In a partial stroke test with step response, the test is cancelled as soon as the drive signal exceeds the delta y-monitoring value.

Test analysis

The analyses of the last three partial stroke tests are saved in the positioner together with a time stamp and the testing mode status (manual or automatic). If the test has not been completed successfully, the reason why the test was cancelled is indicated under "Maintenance alarm". Possible reasons for cancellation depending on the defined cancellation conditions are:

- ▶ *x cancellation* (Code 49 - F2): The valve position was lower than the *x control value*.
- ▶ *y cancellation* (Code 49 - F3): The drive signal fell below the *delta y-monitoring value*.
- ▶ *Tolerance band exceeded* (Code 49 - F4): The deviation of the valve position exceeded the *PST tolerance band*.
- ▶ *Max. test time exceeded* (Code 49 - F5): The test was not completed within the specified period of time.

Further error messages include:

- ▶ *Test man. cancelled* (Code 49 - F6): The test has been manually cancelled.
- ▶ *Measured data storage out of memory* (Code 49 - F7): The scan rate has been selected too short. After 100 measured data per measured variable have been recorded, the logging stops. However, the test is continued.
- ▶ *Aborted by int. solenoid valve/forced venting* (Code 49 - F8): The test was cancelled by the activation of the solenoid valve/forced venting function.
- ▶ *Supply pressure/friction* (Code 49 - F9): An insufficient supply pressure or excessive friction occurred during the test.

- ▶ *Difference w and step start too high:* The *Step start* is outside the range of operating point \pm *Tolerance limit of step tolerance*
- ▶ *Test aborted – Reference variable was changed:* The test was started in PST Auto testing mode and the change in reference variable exceeded the permissible limit.
- ▶ *Test aborted – current too low:* The test was automatically interrupted.

Note: *Until the partial stroke test has not been completed successfully, the positioner sets the No test available (Code 49 - F0).*

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

Analysis of measured data for partial stroke test (step response test):

- ▶ *Overshoot* (relative to the step height) [%]
- ▶ *Dead time* [s]
- ▶ *T63* [s]
- ▶ *T98* [s]
- ▶ *Rise time* [s]
- ▶ *Settling time* [s]

Analysis of measured data for partial stroke test (ramp function):

- ▶ *Overshoot* (relative to the step height) [%]

5.1 Step response test

The dynamic performance of the control valve can be tested by plotting its step response.

The step response of the valve is recorded by performing the partial stroke test with sudden changes in the valve position.

In addition, the following settings are recommended:

- ▶ Deactivate all cancellation conditions of the partial stroke test, providing the process allows it
- ▶ Start partial stroke test manually (PST Man).

After the test is completed, the data are automatically analyzed in the positioner. The analyzed parameters are shown separately for the rising and falling characteristics.

- ▶ *Overshoot* (relative to the step height) [%]
- ▶ *Dead time* [s]
- ▶ *T63* [s]
- ▶ *T98* [s]
- ▶ *Rise time* [s]
- ▶ *Settling time* [s]

Diagnosis – Tests – Partial Stroke Test

- Desired PST testing mode (Code 49 - A2):
PST Man
- Step start (Code 49 - d2): 0.0 to 100.0 %, [95.0 %]
- Step end (Code 49 - d3): 0.0 to 100.0 %, [90.0 %]
- Tolerance limit of step response: 0.1 to 10.0 %, [2.0 %]
- Activation of the ramp function (Code 49 - d4): **No**
- Settling time before test start (Code 49 - d7): 1 to 240 s, [10 s]
- Delay time after step (Code 49 - d8): 1.0 to 240.0 s, [2.0 s]
- Scan rate (Code 49 - d9)¹⁾: 0.2 to 250.0 s, [0.2 s]
- Activation x control (Code 49 - E0):
No²⁾
- Activation delta y-monitoring (Code 49 - E5):
No²⁾
- Activation tolerance band control (Code 49 - E5): **No**²⁾

¹⁾ The *Scan rate* must not be lower than the indicated *Min. recommended scan time* (Code 49 - A5). The *Min. recommended scan time* is calculated from the *Duration of the test*.

²⁾ Recommended setting

Viewing the recorded parameters:

The *Partial Stroke Test* folder contains a graph plotting the parameters required for an analysis of the step response test such as the reference variable *w*, valve position *x*, setpoint deviation *e* and drive signal *y* over time.

6 Full stroke test – FST (d6)

Fig. 17

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

Any full stroke test performed is logged together with its status, i.e. successful/not successful in the *Diagnosis* folder (> *Status messages* > *Logger*).

If the full stroke test could not be performed successfully, the positioner generates the “PST/FST” alarm. Regardless of the status classification, Code 79 is set.

The following listed parameters are temporarily changed while the tests are being performed:

- ▶ Characteristic selection (Code 20) → Linear
- ▶ Required transit time OPEN (Code 21) → Variable
- ▶ Required transit time CLOSED (Code 22) → Variable

Starting the full stroke test

Start the full stroke test by right-clicking *Start test* and select *Execute* in the manual operating mode (**MAN**).

While the test is running, **d6** and **tEst** appear on the positioner display in alternating sequence.

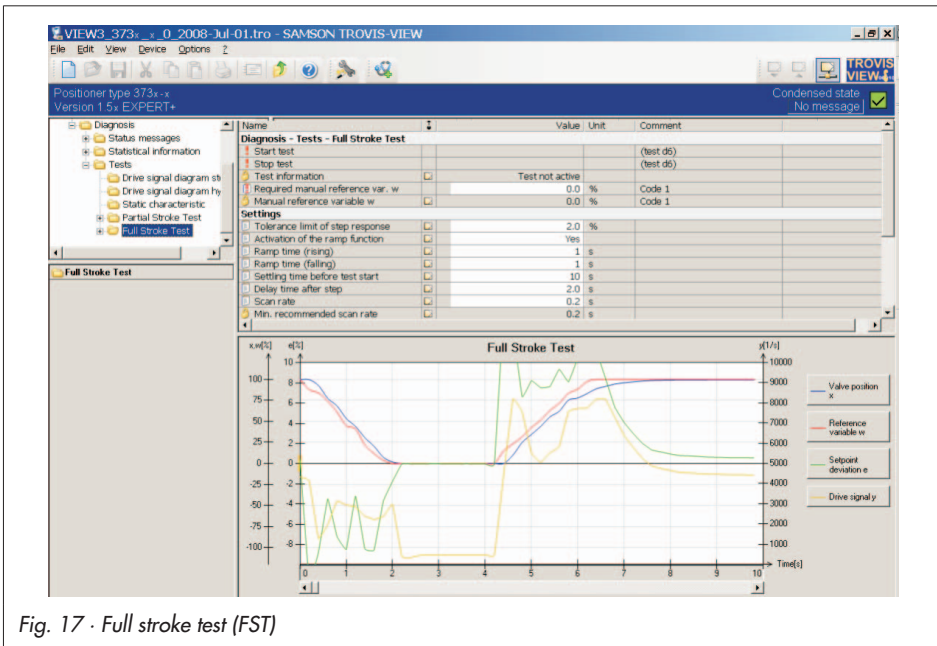


Fig. 17 · Full stroke test (FST)

Cancelling the full stroke test

Cancel the test by right-clicking *Stop test* and select *Execute* or by pressing the rotary pushbutton at the positioner.

After the test has been cancelled, the positioner changes back to the manual operating mode (**MAN**).

After 100 measured values per measured variable have been stored, the logging is stopped. However, the test is still completed. The *Measured data storage out of memory* message is generated by the positioner if the test is not finished when the data logging was stopped.

At the end of the full stroke test, the test status is directly determined to allow the user to know whether the performed test was com-

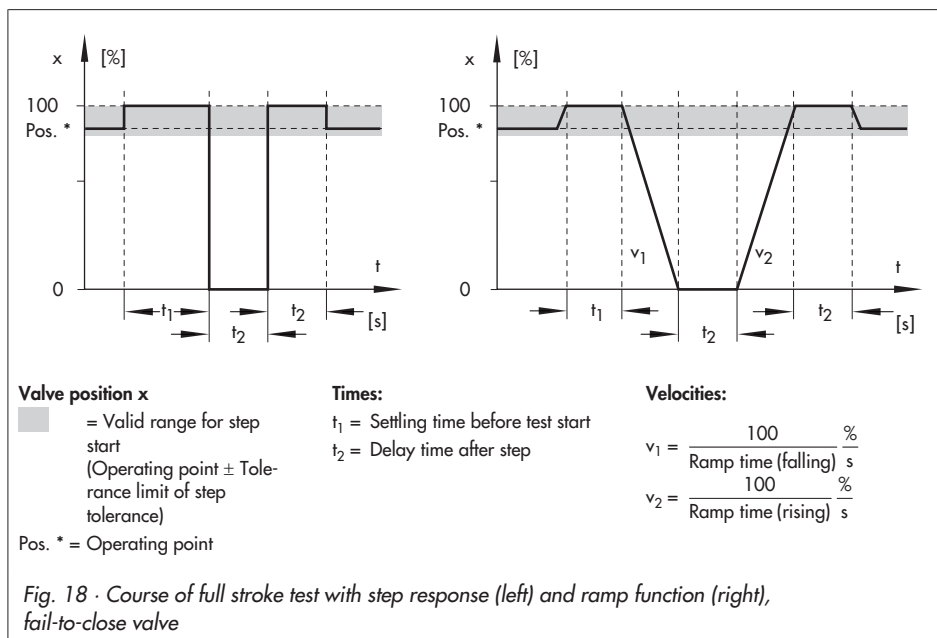
pleted successfully or not. In case a test has not been completed successfully, the possible reasons for cancellation are specified. The test status and the reasons for cancellation can be read in the positioner (Code 49) and in the engineering tool used.

Test description

The valve moves through its entire working range during a full stroke test.

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

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



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

After being activated, the test does not start until the *Settling time before test start* (t_1) has elapsed. This waiting period ensures that the valve has reached its start position.

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

After the *Delay time after step* (t_2) has elapsed, the valve moves back to its operating point (position before the test was performed, reference variable w , pos. *).

The *Tolerance limit of step response* defines the permissible tolerance limit for the step's start and end values.

The *Scan rate* defines the interval at which the measured values are recorded during the test.

Diagnosis – Tests – Full Stroke Test

- Tolerance limit of step response: 0.1 to 10.0 %, [2.0 %]
- Activation of the ramp function: No, [Yes]
- Ramp time (rising)^{1), 2)}: 0 to 9999 s, [1 s]
- Ramp time (falling)^{1), 2)}: 0 to 9999 s, [1 s]
- Settling time before test start: 1 to 240 s, [10 s]
- Delay time after step: 2.0 to 240.0 s, [2.0 s]
- Scan rate³⁾: 0.2 to 30.0 s, [0.2 s]

¹⁾ Parameters are only evaluated if *Activation of the ramp function* is activated (= Yes)

- ²⁾ The *Ramp time (falling)/Ramp time (rising)* must be greater than the corresponding value determined during initialization for *Minimum transit time OPEN* (Code 40)/*Minimum transit time CLOSED* (Code 41)
- ³⁾ The *Scan rate* must not be lower than the indicated *Min. recommended scan time* (Code 49 - A5). The *Min. recommended scan time* is calculated from the *Duration of the test*.

Test analysis

The analyses of the last three full stroke tests are saved in the positioner together with a time stamp and the testing mode status (manual or automatic). If the test has not been completed successfully, the reason why the test was cancelled is indicated under "Maintenance alarm".

Possible reasons for cancellation include:

- ▶ *Max. test duration*: The test is cancelled when the maximum permissible test duration is exceeded.
- ▶ *Test man. cancelled*: The test has been manually cancelled.
- ▶ *Measured data storage out of memory*: The scan rate has been selected too low. After 100 measured data per measured variable have been recorded, the logging stops. However, the test is continued.
- ▶ *Aborted by int. solenoid valve/forced venting*: The test was cancelled by the activation of the solenoid valve/forced venting function.
- ▶ *Supply pressure/friction*: An insufficient supply pressure or excessive friction occurred during the test.
- ▶ *Test aborted – current too low*: The test could not be performed as the auxiliary power was too low.

When a full stroke test has been completed successfully, analyzed parameters are also displayed separately for the rising and the falling characteristics.

Analysis of measured data for a full stroke test (step response test):

- ▶ *Overshoot* (relative to the step height) [%]
- ▶ *Dead time* [s]
- ▶ *T63* [s]
- ▶ *T98* [s]
- ▶ *Rise time* [s]
- ▶ *Settling time* [s]

Analysis of measured data for a full stroke test (ramp test):

- ▶ *Overshoot* (relative to the step height) [%]

7 Binary input function

The optional binary input in Types 3730-2, 3730-3 and 3731-3 allows various actions to be performed which also affect the diagnostic functions.

If an action is started over the binary input, this action is always logged.

Start and end of actions performed over the binary input are determined in the *Edge control binary input* parameter.

The following actions can be performed over the binary input:

- ▶ **Transfer switching state**
The switching state of the binary input is logged.
- ▶ **Set local operation write protection**
Settings cannot be changed at the positioner while the binary input is active. The configuration enabled function in Code 3 is not active.
- ▶ **Start partial stroke test (PST)**
The positioner starts a single partial stroke test. The test is performed according to the settings in the *Tests* folder (> *Partial Stroke Test*). Refer to section 5.
- ▶ **Go to fail-safe reference value**
An open/close valve moves to the entered fail-safe reference value when the positioner is in automatic mode (AUTO). No action is started when the positioner is in manual mode (MAN) or fail-safe position.
No action is started for a control valve.
- ▶ **Switch between AUTO/MAN**
The positioner changes from AUTO mode into MAN mode and vice versa.

No action is started if the positioner is in the fail-safe position.

▶ Start data logger

The data logger is started when the binary input is active. Data are logged according to the settings in the *Statistical information* folder (> *Data logger*). Refer to section 3.2.

▶ Reset diagnosis

Any active diagnostic functions in *Statistical information* (in-service monitoring) and *Tests* (out-of-service diagnostics) are cancelled and the diagnosis data are reset once. Refer to section 2.3.1.

▶ External solenoid valve connected

The triggering of an external solenoid valve is recognized.

▶ Leakage sensor

The "External leakage soon to be expected" error is set. The error is reset when the edge control is set to OFF. The message remains saved in the logging.

Positioner – Options

- Action at active binary input: [Transfer switching state], Set local operation write protection, Start Partial Stroke Test (PST), Go to fail-safe reference variable, Switch between AUTO/MAN, Start data logger, Reset diagnosis, External solenoid valve connected, Leakage sensor
- Edge control binary input:
[On: open switch / Off: closed switch],
On: closed switch / Off: open switch
- Fail-safe reference value ¹⁾: 0.0 to 100.0 %, [50.0 %]

¹⁾ Only relevant with *Action at active binary input* = Go to fail-safe reference variable

8 Diagnostic parameters saved in non-volatile memory

Saved in a non-volatile memory	Data saved if a parameter change is detected	Cyclic saving (24 h)
Statistical information (in-service monitoring)		
Open/Close (not Type 3730-4)	<i>Limit value time analysis, Limit value travel analysis Reference analysis</i>	Analysis
Data logger	<i>Selection, Trigger status, Scan rate, Trigger value, Trigger band, Trigger edge, Pretrigger time, Trigger via condensed state</i>	
Travel histogram		Measured data
Short-term monitoring	<i>Scan rate short-term histogram</i>	
Setpoint deviation histogram		Measured data
Short-term monitoring	<i>Scan rate short-term histogram</i>	
Travel histogram		Measured data
Short-term monitoring		
Drive signal histogram (steady-state)		Measured data
Short-term monitoring		Measured data
Drive signal histogram (hysteresis) (d5)	<i>Start test, Enable time distance, Min. time distance from test, Tolerance band of hysteresis</i>	Measured data
Short-term monitoring		
Lower end position	Measured values when end position changes	
Tests (MAN)		
Drive signal diagram (steady-state) (d1)	<i>Data of reference test Reference time stamp</i>	
Drive signal diagram (hysteresis) (d2)	<i>Data of reference test Reference time stamp</i>	
Static characteristic (d3)		

Diagnostic parameters saved in non-volatile memory

Saved in a non-volatile memory	Data saved if a parameter change is detected	Cyclic saving (24 h)
Partial stroke test (PST) (d4)	<i>PST testing mode, Step start, Step end, Tolerance limit of step response, Activation of the ramp function, Ramp time (rising), Ramp time (falling), Settling time before test start, Scan rate, Max. test duration, Number of step responses, Activation x control, x control value, Activation delta y-monitoring, delta y-monitoring value, Activation tolerance band control, PST tolerance band</i> <i>delta y-monitoring reference value, plotted step, Analysis of measured data, Number of tests</i>	
Full stroke test (FST) (d6)	<i>Tolerance limit of step response, Activation of the ramp function, Ramp time (rising), Ramp time (falling), Settling time before test start, Delay after step, Scan rate, Max. test duration, Number of step responses</i> <i>Plotted step, Analysis of measured data, Number of tests</i>	
General		
Details on actuator and valve data	Yes	
Logging	Yes	
Classification of status messages	Yes	

9 Troubleshooting

Fault	Possible cause	Recommended action	Resetting message
Air supply	Perhaps modified (TEST)	Check air supply. Refer to the section on supply pressure in the standard instructions for the positioner.	Reset y-x signature measured data
	Working at full capacity (TEST)		
	Perhaps not enough (TEST)		
	Perhaps modified		Reset y-x long-term and short-term monitoring
	Working at full capacity		
	Perhaps not enough		
Shifting working range	Shifting working range to closing position	Check the valve working range.	Reset x long-term and short-term histograms
	Shifting working range to max. opening position		
Leakage pneumatics	Perhaps existing (TEST)	Check pneumatic actuator and connections for leakage.	Reset y-x signature measured data
	Perhaps too large (TEST)		Reset y-x long-term and short-term monitoring
	Perhaps too large		
	Perhaps existing		
Limit working range	Down	Check pneumatic accessories and connections for leakage. Check air supply and increase it, if necessary. Refer to the section on supply pressure in the standard instructions for the positioner. Check plug stem for problems caused by an external source.	Reset e short-term histogram
	Up		Reset e long-term histogram
	Modification impossible (terminals)		

Fault	Possible cause	Recommended action	Resetting message
Observing end position/end position trend	Zero point shift monotone down Average above reference	Check plug and seat	Reset lower end position trend
	Zero point shift monotone up Average above reference		
	Zero point alternates Average above reference		
	Zero point shift monotone down Average below reference		
	Zero point shift monotone up Average below reference		
	Zero point alternates Average below reference		
	Zero point alternates Average below reference		
Connection positioner - valve	No optimum travel transmission (TEST)	Check attachment	Reset e short-term histogram
	Perhaps loose		
	Perhaps range limit		
Working range	Mostly near closing position	Reconsider whether the working range is suitable	Reset x long-term histogram
	Mostly near max. opening		
	Mostly closing position		
	Mostly max. opening		
Friction	Much higher over whole range	Check packing	Reset hysteresis long-term and short-term monitoring
	Much lower over whole range		
	Much higher over section		
	Much lower over section		
	Much higher/lower over whole range (TEST)		Reset hysteresis measured data
	Much higher/lower over section (TEST)		

Fault	Possible cause	Recommended action	Resetting message
Actuator springs	Perhaps spring stiffness reduced (TEST)	Check springs in the actuator	Reset y-x signature measured data
	Perhaps bias reduced (TEST)		
	Working at full capacity		
	Working at full capacity (TEST)		
Inner leakage (shut-off)	Perhaps larger than origin	Check plug and seat	Reset e short-term histogram
	Perhaps existing		Reset y-x signature measured data
	Perhaps larger than origin (TEST)		
External leakage	Perhaps soon expected	Check packing	Reset hysteresis long-term and short-term monitoring Reset z long-term histogram
	Perhaps expected		Reset hysteresis measured data
Dynamic stress factor* * This value is included in the <i>Cycle counter histogram</i> in Statistical information	Percentage as information on strain on packing Leakage to the atmosphere message active when greater than 90 %	Check packing	Reset z long-term histogram
PST/FST	PST/FST - Status active	Check cancellation conditions and measured data analysis. Check valve for mal-functions (e.g blockage)	Restart test after correction.
Open/Close (not Type 3730-4)	Open/Close - Status active	Check valve for mal-functions	Reset Open/Close measured data



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