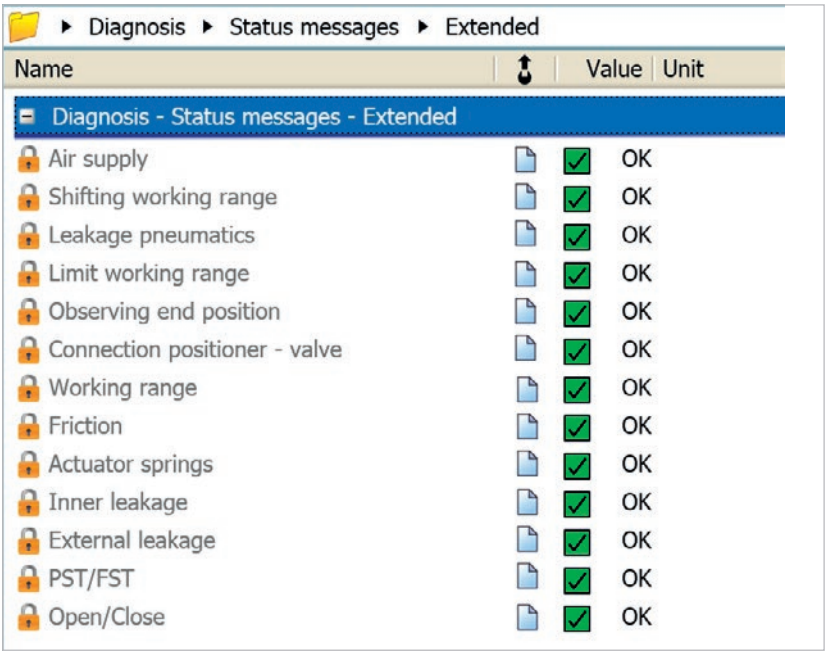
OPERATING INSTRUCTIONS

EB 8389S EN

Translation of original instructions



EXPERTplus Valve Diagnostics

TROVIS SAFE 3731-3 Electropneumatic Positioner

TROVIS SAFE

Firmware version 1.6x

Edition May 2015

The mounting and operating instructions for the devices are included in the scope of delivery. The latest documentation is available on our website at ***www.samson.de > 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

Overview

Throttling service

No configuration required for monitoring

- Travel histogram **S**
  ▶ Section 3.3
- Set point deviation histogram **S**
  ▶ Section 3.4
- Cycle counter histogram **S**
  ▶ Section 3.5
- Drive signal diagram, steady-state **S** **T**
  ▶ Section 3.6
  ▶ Section 4.1
- Trend of travel end position **S**
  ▶ Section 3.8

Configuration required for diagnosis

- Data logger **S**
  ▶ Section 3.2
- Stuffing box **S**
  ▶ Section 3.5
- Drive signal diagram, steady-state **T**
  ▶ Section 4.1
- Drive signal diagram hysteresis **S** **T**
  ▶ Section 3.7
  ▶ Section 4.2
- Static characteristic **T**
  ▶ Section 4.3
- Full stroke test **T**
  ▶ Section 4.5

On/off service

No configuration required for monitoring

- Travel histogram **S**
  ▶ Section 3.3
- Set point deviation histogram **S**
  ▶ Section 3.4
- Cycle counter histogram **S**
  ▶ Section 3.5
- Trend of travel end position **S**
  ▶ Section 3.8

Configuration required for diagnosis

- On/off diagnosis **S**
  ▶ Section 3.1
- Data logger **S**
  ▶ Section 3.2
- Stuffing box **S**
  ▶ Section 3.5
- Static characteristic **T**
  ▶ Section 4.3
- Partial stroke test **S** **T**
  ▶ Section 4.4
- Full stroke test **T**
  ▶ Section 4.5

Note:

- **S** = Statistical information (in-service monitoring) , **T** = Tests (out-of-service diagnostics)
- Tests highlighted in red border require an initialization with reference test
- Tests highlighted in gray can optimize the proper functioning of safety equipment according to IEC 61508 and IEC 61511, provided these tests are performed regularly.

1 Description

1.1 General

These instructions EB 8389 EN supplement the standard mounting and operating instructions for TROVIS SAFE 3731-3 Positioner (▶ EB 8384-3S)

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 completely 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.

Operation using TROVIS-VIEW/DD/DTM/ eDD

EXPERTplus allows the parameters to be viewed or changed using the TROVIS-VIEW software (version 3 or 4) or DD/DTM/eDD.

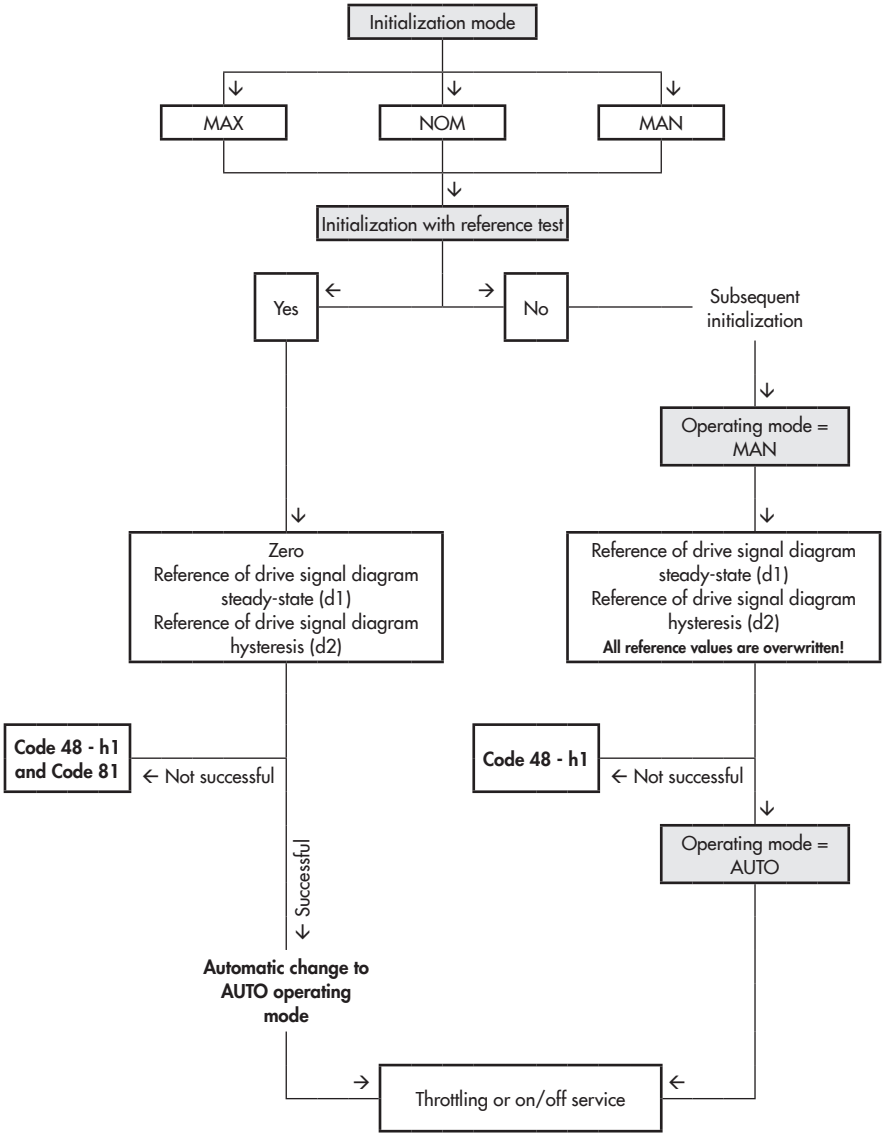
- **TROVIS-VIEW 3 and 4** · Operator interface used to configure various SAMSON devices and define parameters (current version is TROVIS-VIEW 4)
- **DTM** · Device type manager to describe the device and communication properties
- **DD/eDD** · Device description/enhanced device description

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

Local operation

Some parameters can be changed at the positioner as well as over the operator interface. The positioner code of these parameters are written in parentheses. Refer to the mounting and operating instructions of the positioner for a list of all parameters that can be changed at the positioner.

The operation described in the following sections illustrates operation using TROVIS-VIEW. The default settings of the positioner and TROVIS-VIEW are written in square brackets [ ].
Settings highlighted in gray refer to operation using TROVIS-VIEW.


Initialization mode
MAX
NOM
MAN
Initialization with reference test
Yes
No
Subsequent initialization
Operating mode = MAN
Zero
Reference of drive signal diagram steady-state (d1)
Reference of drive signal diagram hysteresis (d2)
Reference of drive signal diagram steady-state (d1)
Reference of drive signal diagram hysteresis (d2)
All reference values are overwritten!
Code 48 - h1 and Code 81
← Not successful
Code 48 - h1
← Not successful
Operating mode = AUTO
← Successful
Automatic change to AUTO operating mode
Throttling or on/off service

1.2 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: maximum range (MAX), nominal range (NOM) and manual adjustment (MAN).

– **Maximum range (MAX)**
  Initialization mode for simple start-up of valves with two clearly defined mechanical end positions, e.g. three-way valves
– **Nominal range (NOM)**
  Initialization mode for all globe valves
– **Manually selected range (MAN)**
  Initialization mode for globe valves requiring OPEN position to be entered manually

The application type, pressure limit and the start-up parameters required for the selected initialization must be entered to initialize the positioner.

i ***Note***

Positioner start-up is described in detail in the mounting and operating instructions (see ▶ EB 8384-3S*).*

During positioner initialization, the proportional-action coefficient Kp and derivative-action time Tv levels are optimally set. If the positioner tends to overshoot impermissibly due to other disturbances, the proportional-action coefficient and derivative-action time can be adapted accordingly. Increment the derivative-action time until the desired behavior is reached. When the maximum value of 4 is reached for the derivative-action time, the proportional-action coefficient can be reduced in steps.

! ***NOTICE***

Changing the proportional-action coefficient influences the set point deviation!

Start-up

– Application type (Code 49 - h0): [Control valve], Open/Close valve
– **Initialization mode** (Code 6): **[Maximum range (MAX)], Nominal range (NOM)** or **Manual adjustment (MAN)**
– Pin position (Code 4): [Off], 17, 25, 35, 50, 70, 100, 200, 300 mm, 90°
– Pressure limit (Code 16): [Off], 3.7, 2.4, 1.4 bar

Settings > Positioner > Performance characteristics

– Required proportional-action coefficient Kp (level) (Code 17): 0 to 17, [7]
– Required derivative-action time Tv (level) (Code 18): Off, 1 to 4, [2]

1.2.1 Reference tests

The monitoring of friction, supply pressure, leakage (pneumatics and to the atmosphere), zero point and actuator springs requires additional reference tests for 'Drive signal diagram steady-state' (test d1) and 'Drive signal diagram hysteresis' (test d2). See ▶ Section 4.1 and section 4.2.

NOTICE

– *The valve moves through its working range during the reference test.*
– *The reference test cannot be performed if the positioner has been initialized in the substitute calibration (SUB) mode.*

Right-click 'Start reference test' in the **Diagnosis** folder and select 'Execute' to start the recording of reference data. *tESt* and *d1* or *d2* appear in alternating sequence on the positioner display.

Note

– *Right-click 'Stop reference test' and select 'Execute' to cancel the reference test.*
– *The positioner records the reference data automatically after initialization if 'Initialization with reference test' is set to Yes.*
– *A new reference test causes the results of existing reference tests to be overwritten and the diagnostic data to be deleted.*
– *If the reference data could not be recorded correctly or are incomplete, Code 48 - h1 is generated in the positioner. If the 'Initialization with reference test' parameter is activated, an incorrect reference test is also indicated in Code 81.*
– *The positioner can still perform its control task properly even if the reference test was not recorded correctly or is incomplete.*
– *Data from the first reference test are used as the reference if no reference data are saved in the positioner on starting the tests for 'Drive signal diagram steady-state' or 'Drive signal diagram hysteresis'*

Diagnostics

– Start reference test (Code 48 - d7)

or

Start-up

– Initialization with reference test (Code 48 - h0): **Yes**, [No]

1.3 Diagnostic functions

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

1. **Statistical information (in-service monitoring)**

   Data are compiled, saved and analyzed by the positioner while the process is running without disrupting the process. The positioner follows the set point to position the valve. A classified status alarm or fault alarm is generated if the positioner detects an event.

2. **Tests (out-of-service diagnostics)**

   Similar to the statistical information function, data are compiled, saved and analyzed by the positioner. However, in this case, the valve position is not determined by the set point, but by the active test.

NOTICE

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, these tests, except for partial stroke testing, can only be performed in the manual mode.

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 solenoid valve is triggered or the forced venting function is activated.

1.3.1 Application type

Different diagnostic functions are available depending on the application type selected in EXPERTplus.

Depending on the application type selected, the positioner behaves differently in the automatic mode:

– **Control valve**

  The positioner uses the set point to position the valve.
  The valve position (current position) appears in % on the display.

– **Open/close (on/off) valve**

  Discrete analysis of the set point
  The valve position (current position) in % and O/C (Open/Close) appear in alternating sequence on the display. See
  ▶ Section 3.1.

1.3.2 Analysis

Table 2 shows the diagnostic functions and their statements on the condition of the valve depending on the application type.

Table 1: *Diagnostic functions and test analysis*

Diagnostic functions	Control valve	Open/Close (on/off) valve [1]	Analysis	See section
Statistical information				
Open/Close	–	•	Breakaway time Transit time Valve end position	3.1, page 21
Data logger	•	•	Depending on trigger status selected	3.2, page 25
Travel histogram	•	○	Shifting working range Working range	3.3, page 30
Set point deviation histogram	•	•	Limit working range Connection positioner-valve Inner (seat) leakage Average set point deviation	3.4, page 33
Cycle counter histogram	•	•	Stuffing box/external leakage Dynamic stress factor	3.5, page 37
Drive signal diagram steady-state	•	○	Air supply Leakage pneumatics Actuator springs	3.6, page 41
Drive signal diagram hysteresis	•	○	Friction External leakage perhaps soon expected	3.7, page 45
Trend of travel end position	•	•	Observing end position Zero shift	3.8, page 51

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

Diagnostic functions	Control valve	Open/Close (on/off) valve [1]	Analysis	See section
Tests				
Drive signal diagram steady-state	•	•	Air supply Leakage pneumatics Actuator springs	4.1, page 55
Drive signal diagram hysteresis	•	•	Friction	4.2, page 59
Static characteristic	•	•	Dead band	4.3, page 62
Partial stroke test (PST)	•	•	Overshooting Dead time T63 T89 Rise time Settling time	4.4, page 65
Full stroke test (FST)	•	•	Overshooting Dead time T63 T89 Rise time Settling time	4.5, page 75

• Full scope of functions

○ Function is performed, but not analyzed

– Function is not performed

2 Monitoring

2.1 Status messages

The valve diagnostics integrated into the positioner generate classified status messages.

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

Standard status messages

Standard status messages contain information on start-up as well as on operation and the condition of the positioner.
Messages are divided into the following main groups:

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

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:

- **Operation > Process data:** Information on current process variables, condensed state and temperature
- **Settings > Positioner > Error control:** Information on total valve travel with configurable limits
- **Positioner > Start-up > Initialization:** List of initialization errors, which are also Resetting the diagnosis contained in the **Diagnosis** folder **(> Status messages)**

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 supply
- Shifting working range
- Leakage pneumatics
- Limit working range
- Observing end position
- Connection positioner-valve
- Working range
- Friction
- Actuator springs
- Inner (seat) leakage
- External leakage
- PST/FST
- Open/Close

Any active diagnostic message is indicated in the positioner by Code 79.
Extended status messages can be classified according to the possible causes. See ▶ Section 3.3 to section 4.5.

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.
– **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.
– **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/invalid process state**
  The positioner is running outside the 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.

You can view the status messages in the **Diagnosis** folder (**> Status messages**) as well as in the **Diagnosis** folder (**> Status messages > Extended**).

2.1.1 Resetting status messages

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

For recommended action concerning the status messages ▶ Section 7.2.

Status messages can be reset individually or using the reset function. ▶ Table 2 contains an overview on how the diagnosis can be reset. The status messages can be reset in the **Diagnosis** folder **(> Reset)** and/or the **Operation** folder **(> Reset)**.

If you want to keep measured data and the analysis after resetting the positioner, it is possible to upload them onto a computer.

Resetting single status messages

– 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. See the standard instructions of the positioner (▶ EB 8384-3S).
– On resetting histograms and diagrams, the data for short-term monitoring are also reset.
– Resetting measured data does not cause the diagnostic parameters and reference value to be reset as well.
– The positioner does not need to be re-initialized after resetting.

Resetting the diagnosis

Code 36 - Diag

– Data from Statistical information and Tests are reset according to ▶ Table 3.
– The reference value of 'Trend of travel end position' (Statistical Information) is deleted.
– The reference values of Tests ('Drive signal diagram steady-state' and 'Drive signal diagram hysteresis') remain saved.
– Status classification and data logs remain saved.
– The positioner does not need to be re-initialized after resetting.

If the diagnosis is to be reset at regular intervals, enter the time in "Required time 'Reset diagnosis". The setting "00:00:00" or "0" causes the resetting at regular intervals to be deactivated.

Operation > Reset

– Reset diagnosis (Code 36 - Diag)
– Required time 'Reset diagnosis' (Code 48 - h3): configurable as required, [0.00:00:00 d.h:min:s]

Start with default values

Code 36 - Std

– Data from Statistical information and Tests are reset according to ▶ Table 3.
– Reference values are deleted.
– Status classification and data logs are deleted.
– The positioner must be re-initialized after resetting.

NOTICE

Before mounting the positioner on a new control valve, perform a reset by activating Code 36 - Std and re-initialize the positioner.

Operation > Reset

– Start with default values (Code 36 - Std)

Table 2: *Reset functions*

All adjusted parameters and recorded measured values of the specified diagnostic test are reset, if not listed separately.

Function		Resetting single status messages	Code 36 - Diag	Code 36 - Std
Operating hours counter				
Device switched on since (last) initialization		NO	YES	YES
Device in closed loop since initialization		NO	YES	YES
Status classification		NO	NO	YES
Logging		YES	NO	YES
Statistical information				
Open/Close [1)]	Parameters	YES	NO	YES
	Measured values	YES	YES	YES
Data logger		NO	YES	YES
Travel histogram x		YES	YES	YES
Short-term monitoring		YES	YES	YES
Set point deviation histogram e		YES	YES	YES
Short-term monitoring		YES	YES	YES
Cycle counter histogram		YES	YES	YES
Short-term monitoring		YES	YES	YES
Drive signal diagram steady-state		YES	YES	YES
Short-term monitoring		YES	YES	YES
Drive signal diagram hysteresis (d5)		YES	YES	YES
Short-term monitoring		YES	YES	YES
Trend of travel end position	Reference value	YES	YES	YES
	Parameters, measured values	YES	YES	YES
Tests				
Drive signal diagram steady-state (d1)	Reference values	NO	NO	YES
	Measured values	YES	YES	YES
Drive signal diagram hysteresis (d2)	Reference values	NO	NO	YES
	Measured values	YES	YES	YES
Static characteristic (d3)		NO	YES	YES
Partial stroke test (PST) (d4)		YES	NO	YES
Full stroke test (FST) (d6)		YES	NO	YES

2.2 Condensed state

To provide a better overview on the condition of the valve assembly, 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 which condensed state is set.

The condensed state appears in TROVIS-VIEW on the right-hand side of the info bar and in the **Diagnosis** folder (**> Status messages**). See ▶ Table 3 for a description of the icons and their meaning.

Additionally, the condensed state can be used to trigger the data logger. See ▶ Section 3.2.2.

Note

The condensed state is marked by ☐ until the positioner data have been uploaded.

Diagnosis > Status messages

– Condensed state (Code 48 - d6)

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

2.2.1 Condensed at the fault alarm output

In positioners with a fault alarm output, the condensed state can also be read out at the fault alarm output if one of the following conditions occurs:

1. Condensed state 'Maintenance alarm' is activated.
2. Condensed state 'Function check' is activated and the fault alarm output is activated.
3. Condensed state 'Maintenance required' is activated and the fault alarm output is activated.

Settings > Positioner > Error control

2. – Fault alarm at condensed state 'Function check' (Code 32): [**Yes**]
3. – Fault alarm at condensed state 'Maintenance required' (Code 33) : [**Yes**]

2.3 Logging

The last 30 generated messages are saved in the positioner with a time-stamp (logged by the operating hours counter).

You can view these messages in TROVIS-VIEW 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 '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.*

Settings > Positioner > Error control

– Logging of int. solenoid valve: [Yes], No

– Min. clearance new logging int. solenoid valve: 0 to 5000 s, [300 s]

3 Statistical information

The positioner records the *set point w, valve position x, drive signal y* and *set point deviation e* even while the process is running to obtain information on 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, a background hysteresis test can detect any changes in friction.

The monitoring functions in Statistical information do not have any affect on the running process.

The measured data are analyzed after the positioner has been in automatic mode or in manual mode for an hour. However, the analysis for the 'Cycle counter histogram' and 'Trend of travel end position' start directly after the positioner changes to automatic mode or manual mode.

Table 3: *Condensed state reading*

Status message	TROVIS-VIEW 4/DTM	Positioner	Priority
Maintenance alarm	red		
Function check [1]	orange	Text e.g. tESting, tunE or tESt	
Out of specification/invalid process state	yellow	blinking	
Maintenance demanded/ maintenance required	blue		
No message, OK	green		

START-UP

PROCESS

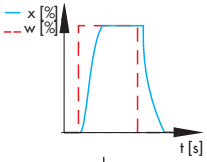
Prerequisite:
– Application type: Open/Close

Operating point, Limit fail-safe position, Limit operating point

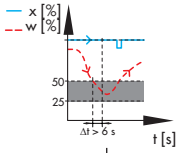
Limit value time analysis
Limit value travel analysis
Status classification (NE 107)
On/off status activated

Define parameters for partial stroke test, see ▶ Section 4.4

On/off diagnosis



Discrete set point analysis PST



First analysis after defining parameters
= **Reference**

Breakaway time, transit time, valve end position (rising/falling)

Analysis (NE 107)/
logged by operating hours counter
Open/Close status activated

Analysis, see ▶ Section 4.4

Reset measured data 'Open/Close'

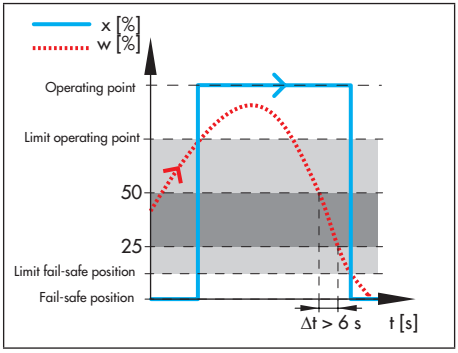
Reset all parameters 'Open/Close'

3.1 Open/close (on/off) valve

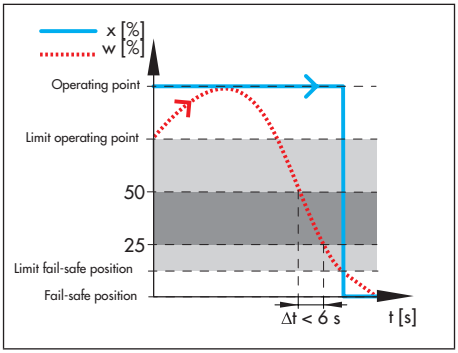
The travel range of open/close (on/off) is defined by the fail-safe position and the operating point. As a result, the following parameters to determine the working range and set point range are not analyzed and cannot be changed.

- Travel/angle range start/end (Code 8/9)
- Travel/angle range lower/upper limit (Code 10/11)
- Reference variable range start/end (Code 12/13)

The discrete analysis of the set point is performed in automatic mode.

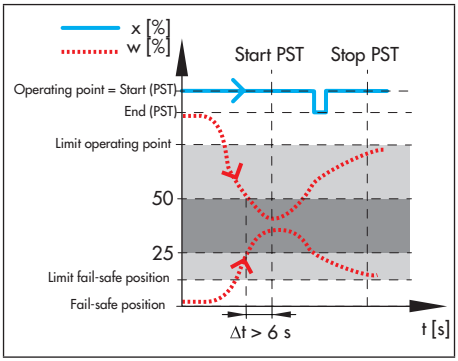


If the set point (- - -) is below 'Limit operating point' when the automatic mode starts, the valve (—) moves to the fail-safe position. If the set point increases and exceeds 'Limit operating point', the valve moves to the 'Operating point'. The valve moves back to the fail-safe position (0 % in the example) if the set point then falls below 'Limit fail-safe position'.



If the set point (- - -) is above 'Limit operating point' when the automatic mode starts, the valve (—) moves to the operating point. The valve moves back to the fail-safe position (0 % in the example) if the set point then falls below 'Limit fail-safe position'.

Starting the partial stroke test (PST)



A partial stroke test is started when the set point (- - -) moves in the range between 25 and 50 % of the travel and remains there for longer than six seconds. See ▶ Section 4.4.1.

The PST diagnostic parameter 'Step start' must be within the defined range of the

'Tolerance limit of step response' for the partial stroke test to start.

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

Canceling the partial stroke test (PST)

The partial stroke test is canceled whenever the set point (- - -) leaves the range between 'Limit fail-safe position' and 'Limit operating point'.

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

Defining parameters

1. Select 'Open/Close valve' as the application type.
2. Set parameters for on/off valve.
3. Set parameters for partial stroke test (PST).

Start-up

1. – Application type (Code 49 - h0): Open/Close valve

Settings > Positioner > Reference variable

2. – Operating point (Code 49 - h1): 0.0 to 100 %, [100 %]
   – Limit fail-safe position (Code 49 - h2): 0.0 to 20.0 %, [12.5 %]
   – Limit operating point (Code 49 - h5): 55.0 to 100.0 %, [75.0 %]

Diagnosis > Tests > Partial stroke test

3. See ▶ Section 4.4

3.1.1 On/off diagnosis

3730-2	3730-3	3731-3	3730-4	3730-5
•	•	•		•

The diagnosis for on/off valves provides statements on the valve end position, transit times (rising/falling) and the breakaway times (rising/falling). Data are constantly recorded in automatic mode. This monitoring function does not need to be activated.
The positioner compares the current breakaway time, transit time and valve position with the values recorded during the reference measurement (first analysis) while the plant is running.

Defining parameters

1. Enter limits for monitoring. See ▶ Section 3.1.2.
2. Select classification for status message.

Diagnosis > Statistical information > Open/Close

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

Settings > Positioner > Error control > Classification report > Extended > Open/Close

2. – Open/Close status active (Code 49- h9): [⊗], ◆, ⊗, ⚠

3.1.2 Analysis and monitoring

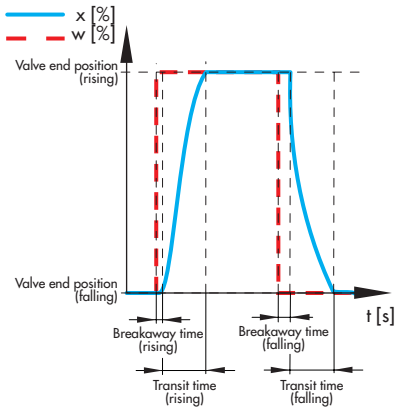


Fig. 1: *Analysis of the on/off diagnosis*

The analysis pinpoints a fault when at least one of the following conditions is met while the valve is moving:

– The current 'Breakaway time (rising)' differs from the reference value by the amount entered in 'Limit value time analysis'.
– The current 'Breakaway time (falling)' differs from the reference value by the amount entered in 'Limit value time analysis'.
– The current 'Transit time (rising)' differs from the reference value by the amount entered in 'Limit value time analysis'.
– The current 'Transit time (falling)' differs from the reference value by the amount entered in 'Limit value time analysis'.
– The current 'Valve end position (rising)' differs from the reference value by the amount entered in 'Limit value travel analysis'.
– The current 'Valve end position (falling)' differs from the reference value by the amount entered in 'Limit value travel analysis'.

If one of these conditions is met, the positioner generates an 'Open/Close' message according the selected status classification.

Diagnosis > Status messages > Extended

– Open/Close: ✓, ◆, ⊗, ⚠

3.1.3 Resetting single status messages

The message and analysis are reset by right-clicking "Reset measured data 'Open/Close" and selecting 'Execute'.

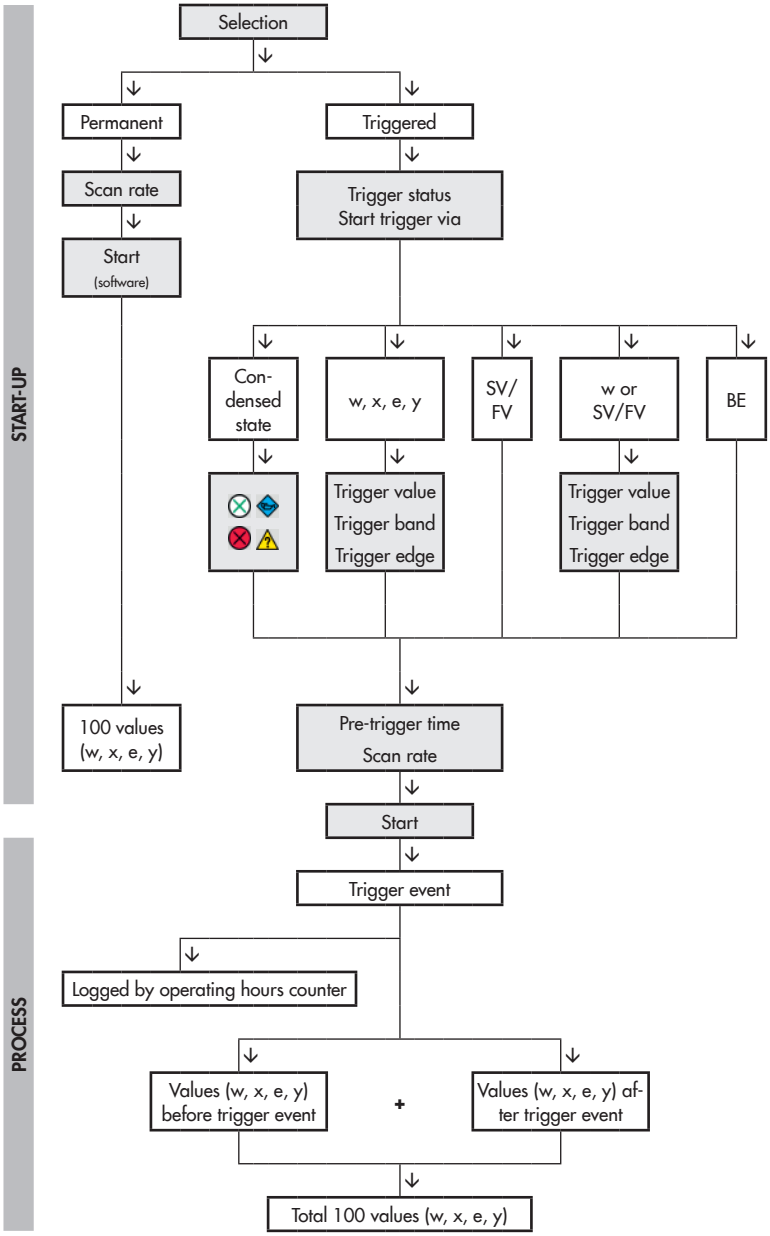
The parameters for the on/off valve and the limit values are reset by right-clicking "Reset all parameters 'Open/Close" and selecting 'Execute'.

The positioner saves the reference analysis and two further test analyses. The analysis of the oldest test is deleted when another test is performed.

Diagnosis > Status messages > Reset

– Reset measured data 'Open/Close'

– Reset all parameters 'Open/Close'


START-UP
PROCESS
Selection
Permanent
Triggered
Scan rate
Trigger status
Start trigger via
Start
(software)
Con-
densed
state
w, x, e, y
SV/
FV
w or
SV/FV
BE
Trigger value
Trigger band
Trigger edge
Trigger value
Trigger band
Trigger edge
100 values
(w, x, e, y)
Pre-trigger time
Scan rate
Start
Trigger event
Logged by operating hours counter
Values (w, x, e, y)
before trigger event
+
Values (w, x, e, y) af-
ter trigger event
Total 100 values (w, x, e, y)

3.2 Data logger

The data logger records the measured variables (*valve position x, set point w, set point deviation e* and *drive signal y*). The recorded data are plotted against time in a graph.

i ***Note***

The data logger is interrupted and must be reactivated when one of the following events occurs.

- *Change of the operating mode*
- *Air supply failure*
- *Failure of power supply of the positioner*
- *Failure of power supply of the external solenoid valve*

3.2.1 Permanent data logging

The measured variables are logged at the rate defined in 'Scan rate' and saved in a circular buffer, which holds 100 data points per measured variable at one time.

i ***Note***

*You can read the measured data logged over the past 24 hours from the 'Data logger' graph when the **Diagnosis** folder (**> Statistical information > Data logger**) is left open over this period.*

Defining parameters

1. Select 'Permanent' (Selection).
2. Enter scan rate.
3. Start data logger.

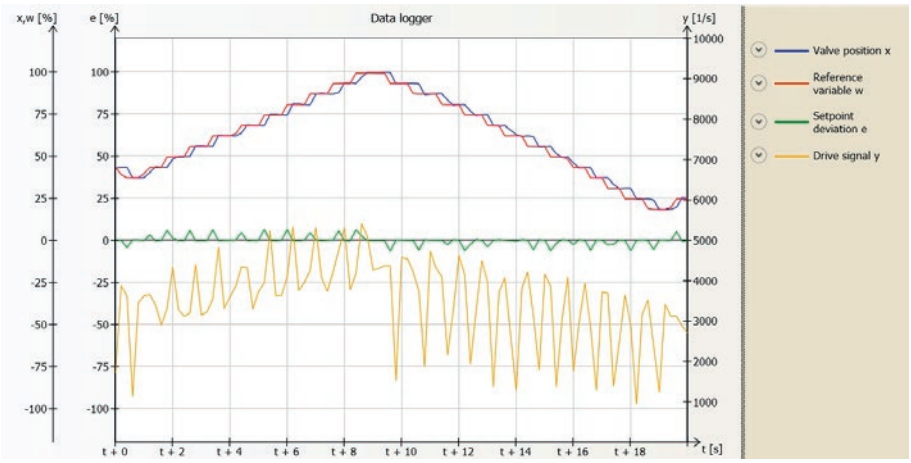


Fig. 2: *Diagnosis > Statistical information > Data logger*

The 'Test information' status indicates 'Test active'.

	Diagnosis > Statistical information > Data logger
1.	– Selection: **[Permanent]**
2.	– Scan rate: 0.2 to 3600.0 s, [1.0 s]
3.	– Start data logger

Note

Right-click 'Stop data logger' and select 'Execute' to stop the data logger ('Test information' = 'Test not active').

3.2.2 Triggered data logging

Measured values are saved in a circular buffer after the event defined in 'Start trigger via' has occurred (see ▶ Section 3.2.2.1 to section 3.2.2.5). The event that has triggered data logging is recorded. Data logging is terminated after 100 measured values per measured variable have been saved in the circular buffer. The 'Scan rate' determines the time between recordings. A 'Pre-trigger time' greater than 0 also leads to the measuring values before the triggering event for the time selected being included in the 100 measured values per measured variable. The 'Pre-trigger time' may include the value 100 x 'Scan rate' at the maximum.

Defining parameters

1. Select 'Trigger' (Selection).
2. Select the triggering event.
3. Enter scan rate.
4. Start data logger.
   The 'Test information' status indicates 'Test active'. At the end of data logging, the progress flag reads 'Memory full, ending measuring'.

Note

Right-click 'Stop data logger' and select 'Execute' to stop the data logger ('Test information' = 'Test not active').

3.2.2.1 Triggered by condensed state

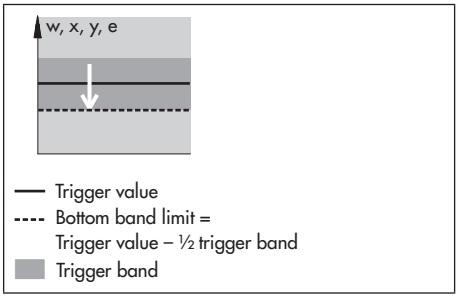
The measured values are included in the triggered data logging when the condensed state defined in 'Start trigger via condensed state' arises.

	Diagnosis > Statistical information > Data logger
1.	– Selection: **Trigger**
2.	– Trigger status: **Start trigger via condensed state** – Pre-trigger time: 0.0 s to 100 x 'Scan rate', [0.0 s] – Trigger via condensed state: No message, [Maintenance required], Maintenance demanded, Out of specification, Maintenance alarm
3.	– Scan rate: 0.2 to 3600.0 s, [1.0 s]
4.	– Start data logger

3.2.2.2 Triggered by set point, valve position, drive signal or set point deviation

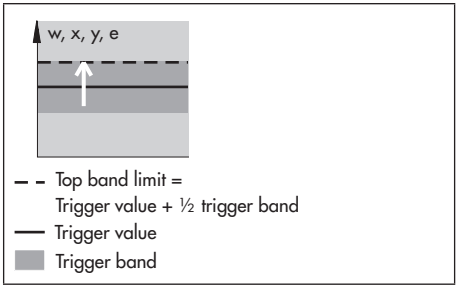
The measured values are included in the triggered data logging when the conditions for the selected measured variable (*set point w, valve position x, set point deviation e* or *drive signal y*) defined in 'Trigger value', 'Trigger band' and 'Trigger edge' are met.

'Trigger edge' = Low signal/falling edge/ bottom band exit



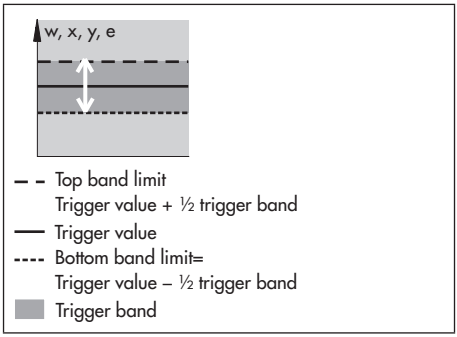
The conditions for starting a trigger event are met when the value falls below the limit ('Trigger value' – ½ 'Trigger band').

'Trigger edge' = High signal/rising edge/ top band exit



The conditions for starting a trigger event are met when the value exceeds the limit ('Trigger value' + ½ 'Trigger band').

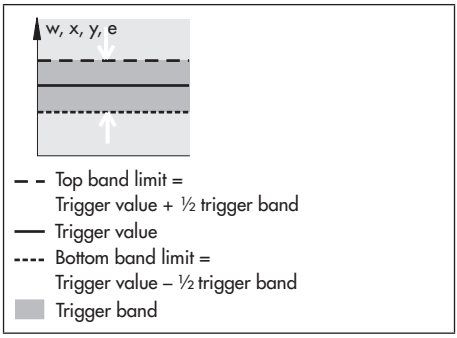
'Trigger edge' = Band exit



The conditions for starting a trigger event are met when the value falls below the lower limit ('Trigger value' – ½ 'Trigger band') or exceeds the upper limit ('Trigger value' + ½ 'Trigger band').

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

'Trigger edge' = Band entry



The conditions for starting a trigger event are met when the value exceeds the lower

limit ('Trigger value' – ½ 'Trigger band') or falls below the upper limit ('Trigger value' + ½ 'Trigger band').

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

Note

The bottom band limit assumes the value 0.0 % or 0.0 ⅕ at the lowest. The top band limit assumes the value 100.0 % or 100.0 ⅕ at the most.

Diagnosis > Statistical information > Data logger

1. – Selection: **Trigger**
2. – Trigger status: Start trigger via set point, valve position, drive signal or set point deviation
   – Trigger value:
   0.0 to 100.0 %, [99.0 %] (set point, valve position, set point deviation)
   0.0 to 10000.0 ⅕, [99.0 ⅕] (drive signal)
   – Trigger band:
   0.0 to 100.0 %, [99.0 %] (set point, valve position, set point deviation)
   0.0 to 10000.0 1/s, [99.0 1/s] (drive signal)
   – Pre-trigger time:
   0.0 s to 100 x 'Scan rate', [0.0 s]
   – Trigger edge: [Low signal/falling edge/bottom band exit], High signal/rising edge/top band exit, Band exit, Band entry
3. – Scan rate: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

3.2.2.3 Triggered by internal solenoid valve/forced venting

Triggering by the internal solenoid valve/forced venting is only active when an internal solenoid valve/forced venting is installed in the positioner. See 'Internal solenoid valve/forced venting' reading (Code 45).

The measured values are included in the triggered data logging when the solenoid valve is triggered or the forced venting is activated.

Diagnosis > Data logger

1. – Selection: **Trigger**
2. – Trigger status:
   Start trigger via int. sol. valve/forced venting
   – Pre-trigger time:
   0.0 s to 100 x 'Scan rate', [0.0 s]
3. – Scan rate: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

3.2.2.4 Triggered by set point or internal solenoid valve/forced venting

Triggering by the internal solenoid valve/forced venting is only active when an internal solenoid valve/forced venting is installed in the positioner. See 'Internal solenoid valve/forced venting' reading (Code 45).

The measured values are included in the triggered data logging when one of the conditions defined in 'Start trigger via internal so-

lenoid valve/forced venting' or 'Start trigger via set point' are met.

Diagnosis > Data logger

1. – Selection: **Trigger**
2. – Trigger status:
   Start trigger via set point/int. sol. valve/ forced venting
   – Trigger value:
   0.0 to 100.0 %, [99.0 %]
   – Trigger band: 0.0 to 100.0 %, [99.0 %]
   – Pre-trigger time:
   0.0 s to 100 x 'Scan rate', [0.0 s]
   – Trigger edge: [Low signal/falling edge/bottom band exit], High signal/rising edge/top band exit, Band exit, Band entry
3. – Scan rate: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

3.2.2.5 Triggered by binary input

Positioners can be optionally fitted with a binary input. Triggering by the binary input is only active when the positioner is fitted with a binary input.

The measured values are included in the triggered data logging when the state of the binary input changes.

Diagnosis > Statistical information > Data logger

1. – Selection: **Trigger**
2. – Trigger status:
   Start trigger via binary input
   – Pre-trigger time:
   0.0 s to 100 x 'Scan rate', [0.0 s]
3. – Scan rate: 0.2 to 3600.0 s, [1.0 s]
4. – Start data logger

3.3 Travel histogram

The valve travel histogram is a statistical analysis of the plotted valve positions. It provides information about the range in which valve mainly works during its service life and whether the working range is possibly shifting.

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

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

– The 'Average value x long' indicates the average class assignment of the valve position over the 'Observation period.'
– The 'Number of measurement values' shows the total number of values were recorded during the 'Observation period'.
– 'Observation period'

The measured data are saved every 24 hours in the positioner.

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' and analyses the last 100 measured values.

– The 'Average value x short' contains the average class assignment for the last 100 measured values.

The positioner saves the valve positions in a circular buffer, which holds 100 measured values at one time.

Note

On changing scan rate in 'Scan rate short-term histogram', all existing measured values are deleted from the circular buffer.

Defining parameters

1. Set 'Scan rate short-term histogram'.
2. Select classification for status messages.

	Diagnosis > Statistical information > Travel histogram x > Short-term
1.	– Scan rate short-term histogram: 1 to 3600 s, [1 s] [1)]

	Settings > Positioner > Error control > Classification report > Extended > ...
2.	Shifting working range
	– Shifting working range to closing position: [⊗], ◆, ⊗, ⚠
	– Shifting working range to max. opening position: [⊗], ◆, ⊗, ⚠
	Working range
	– Mostly near closing position: [⊗], ◆, ⊗, ⚠
	– Mostly near max. opening: [⊗], ◆, ⊗, ⚠
	– Mostly closing position: [⊗], ◆, ⊗, ⚠
	– Mostly max. opening: [⊗], ◆, ⊗, ⚠

3.3.1 Analysis and monitoring

Diagnosis > Status messages > Extended

– Shifting working range: ☑, ◈, ⊗, ⚠

– Working range: ☑, ◈, ⊗, ⚠

Analysis of the histogram for control valves starts one hour after the observation period begins. No analysis is performed for on/off valves.

If the control valve mainly works during the observation duration near or in one of the end positions, the positioner generates the 'Working range' message with the selected status classification.

For analysis of the short-term monitoring, a complete set of data (100 measured values) is required.

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

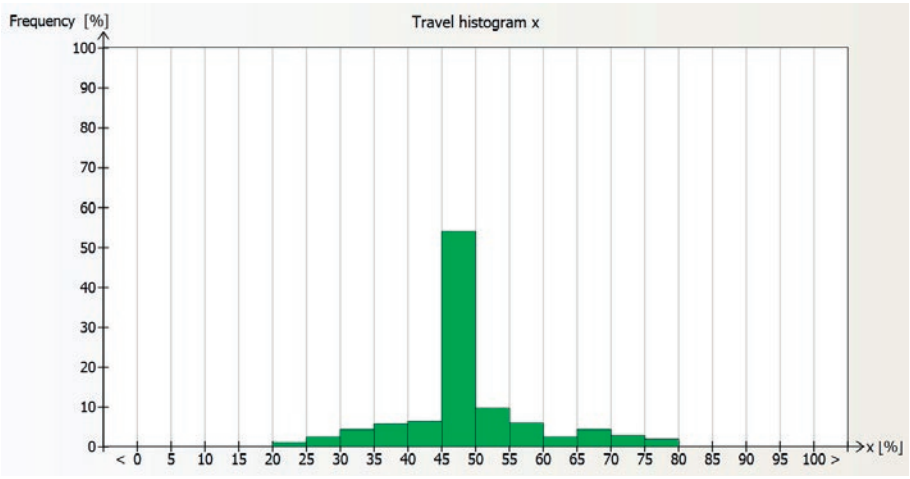


Fig. 3: *Diagnosis > Statistical information > Travel histogram x*

3.3.2 Resetting single status messages

The 'Working range' and the 'Shifting working range' messages can be reset by selecting and executing the command "Reset 'Travel histogram x". This command resets all diagnostic parameters and measured data of the histogram and the short-term monitoring.

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

Diagnosis > Status messages > Reset

– Reset 'Travel histogram x'

– Reset 'Travel histogram x – short-term'

3.4 Set point deviation histogram

The set point deviation histogram contains a statistical analysis of any set point deviations recorded. It provides information on to which extent a set point deviation has occurred during the valve service life and whether faults may occur due to a restricted working range or due to seat leakage.

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

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

– The 'Average value e long' indicates the average class assignment of the set point deviation over the 'Observation period.'
– The 'Number of measurement values' shows the total number of values were recorded during the 'Observation period'.
– 'Observation period'
– 'Absolute value of max. set point deviation' indicates the largest set point deviation measured during the observation period.

The measured data are saved every 24 hours in the positioner.

Short-term monitoring

In order to be able to recognize any short-term changes in set point deviation, the positioner records the set point deviation according to the adjusted 'Scan rate short-term histogram' and analyses the last 100 measured values.

– The 'Average value e short' contains the average class assignment for the last 100 measured values.

The positioner saves the set point deviations in a circular buffer, which holds 100 measured values at one time.

Note

On changing scan rate in 'Scan rate short-term histogram', all existing measured values are deleted from the circular buffer.

Defining parameters

1. Set 'Scan rate short-term histogram'.
2. Select classification for status messages.

Diagnosis > Statistical information > Set point deviation histogram e > Short-term

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

Settings > Positioner > Error control > Classification report > Extended > ...

2. Limit working range
   – Down: [⊗], ◆, ●, ⚠
   – Up: [⊗], ◆, ●, ⚠
   – Modification impossible (jammed): [⊗], ◆, ●, ⚠

   Connection positioner-valve
   – No optimum travel transmission (TEST) [⊗], ◆, ●, ⚠
   – Perhaps loose/(TEST): [⊗], ◆, ●, ⚠

– Perhaps range limit:
[⊗], ◆, ⊗, ⚠

Inner (seat) leakage

– Perhaps existing:
[⊗], ◆, ⊗, ⚠

3.4.1 Analysis and monitoring

Analysis of the histogram starts one hour after the observation period begins.

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

Set point deviations greater than 1 % following in quick succession pinpoint to a limitation of the upper working range. In this case, the positioner generates the 'Limit working range' message with the selected status classification.

Set point deviations smaller than 1 % following in quick succession pinpoint to a limitation of the lower working range or to seat leakage. In this case, the positioner generates the 'Limit working range' and 'Inner leakage' messages with the selected status classifications.

If almost all set point deviations during the short-term monitoring are greater than 1 % or smaller than –1 %, this may indicated that the actuator or valve stem is jammed. In this case, the positioner generates the 'Limit working range' and 'Connection positioner - valve' messages with the selected status classifications.

Diagnosis > Status messages > Extended

– Limit working range: ☑, ◆, ⊗, ⚠

– Connection positioner-valve: ☑, ◆, ⊗, ⚠

– Inner (seat) leakage: ☑, ◆, ⊗, ⚠

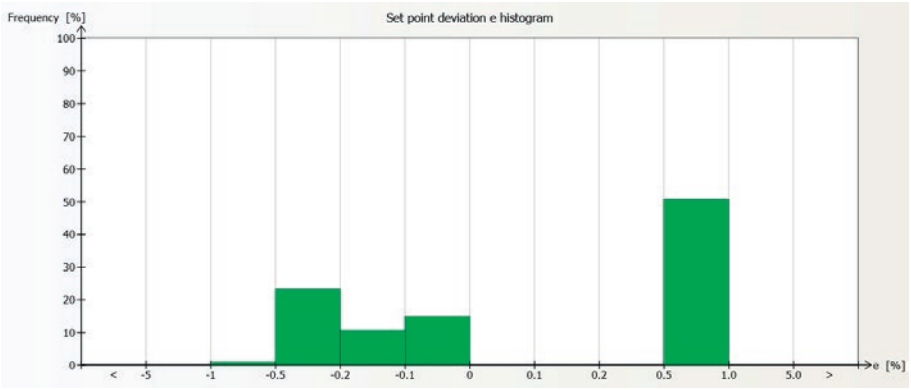


Fig. 4: *Diagnosis > Statistical information > Set point deviation histogram e*

3.4.2 Resetting single status messages

The 'Inner leakage' and 'Limit working range' messages can be reset by selecting and executing the command "Reset 'Set point deviation histogram e" or "Reset 'Set point deviation histogram e - short-term". The 'Connection positioner-valve' message can be reset by selecting and executing the command 'Set point deviation histogram e - short-term".

By selecting and executing the "Reset 'Set point deviation histogram e" command, all diagnostic parameters and measured data of the histogram and the short-term monitoring are reset.

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

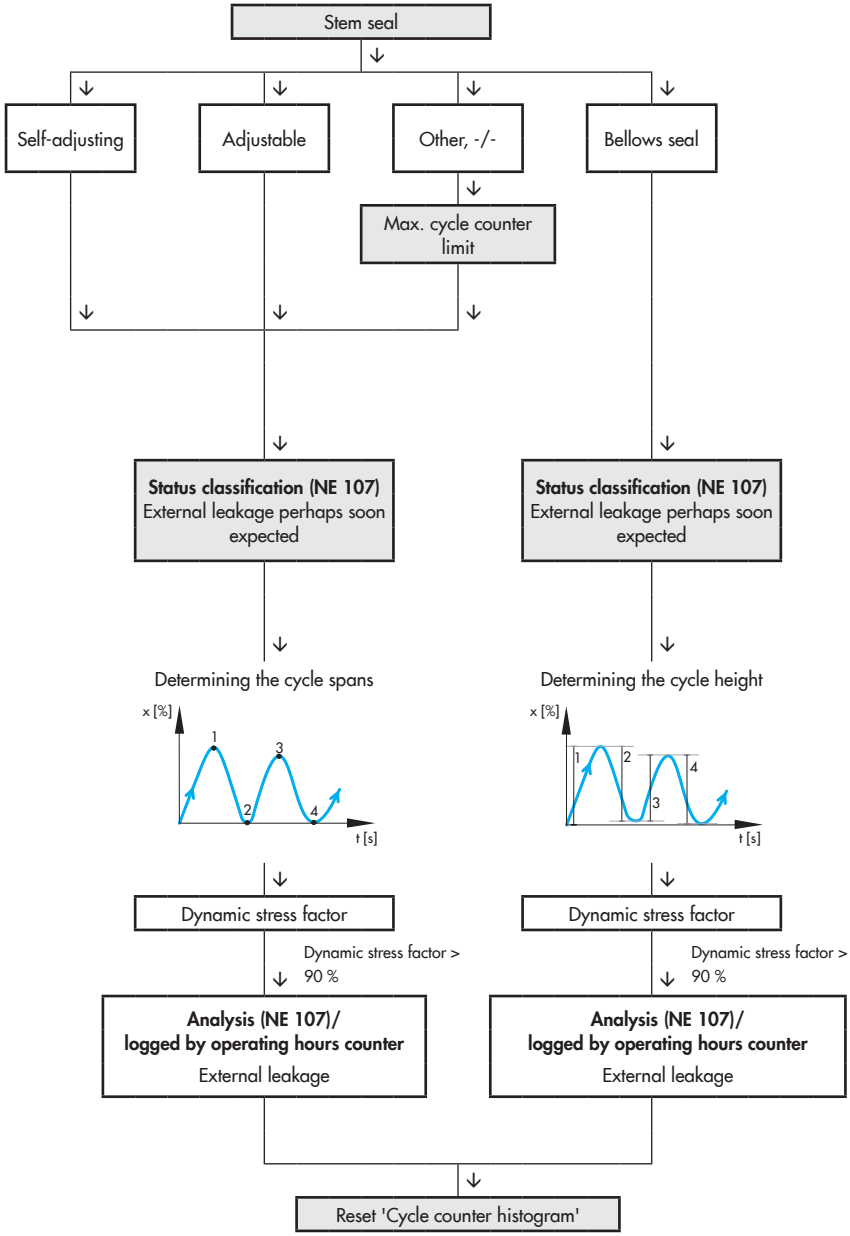
Diagnosis > Status messages > Reset

– Reset 'Set point deviation histogram e'

– Reset 'Set point deviation histogram e – short-term'

START-UP

PROCESS



3.5 Cycle counter histogram

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.

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

The positioner records the number of cycle spans when the 'Stuffing box' (stem seal) setting is set to 'Self-adjusting', 'Adjustable packing', 'Other' or '-/-'. A cycle span starts at the point where the valve stroke changes direction until the point where it changes direction again.

The positioner records the cycle height when the 'Stuffing box' (stem seal) setting is set to 'Bellows seal'. The valve stroke between these two changes in direction is the cycle height.

The cycle spans or cycle heights are assigned to classes. The distribution showing how often the cycle span or height occurred within a class is shown in a bar graph.

– The 'Average value z long' indicates the average class assignment of the cycle height over the 'Number of measurement values'.
– The 'Number of measurement values' shows the total number of values recorded.

The measured data are saved every 24 hours in the positioner.

Short-term monitoring

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

The positioner saves the cycles in a circular buffer, which holds 100 measured values at one time.

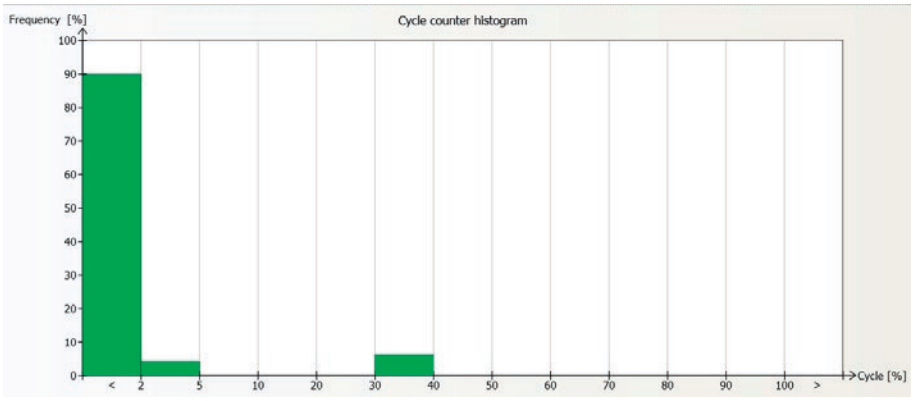


Fig. 5: *Diagnosis > Statistical information > Cycle counter histogram*

– The 'Average value e short' contains the average class assignment of cycle heights for the last 100 measured values.

Defining parameters

1. Select the type of stem seal.
   When 'Other' is selected for 'Stuffing box', the additional parameter 'Max. cycle counter limit' must also be set.
2. Select classification for status messages.

	Settings > Identification > Positioner > Valve
1.	– Stuffing box: [-/-], Self-adjusting, Adjustable packing, Bellows seal, Other – Max. cycle counter limit [1]: 1 to 1000000000, [1000000]

	Settings > Positioner > Error control > Classification report > Extended > ...
2.	External leakage – Perhaps soon expected: [⊗], ◈, ⊗, ⚠

[1] Setting only with 'Stuffing box' = Other

3.5.1 Analysis and monitoring

Analysis of the histogram starts directly after the change to manual or automatic mode.

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.

An 'External leakage' message is generated with the selected status classification whenever:

– The number of measured cycle spans exceeds 450000 when 'Self-adjusting' is selected as the stem seal.
– The number of measured cycle spans exceeds 180000 when 'Adjustable packing' is selected as the stem seal.
– The number of measured cycle spans exceeds 90 % of the 'Max. cycle counter limit' when 'Other' is selected as the stem seal.
– The number of measured cycle heights exceeds 180000 when 'Bellows seal' is selected as the stem seal.

Diagnosis > Statistical information > Cycle counter histogram
– Dynamic stress factor

Diagnosis > Status messages > Extended
– External leakage: ☑, ◈, ⊗, ⚠

3.5.2 Resetting single status messages

The 'External leakage' message can be reset by selecting and executing the command "Reset 'Cycle counter histogram".

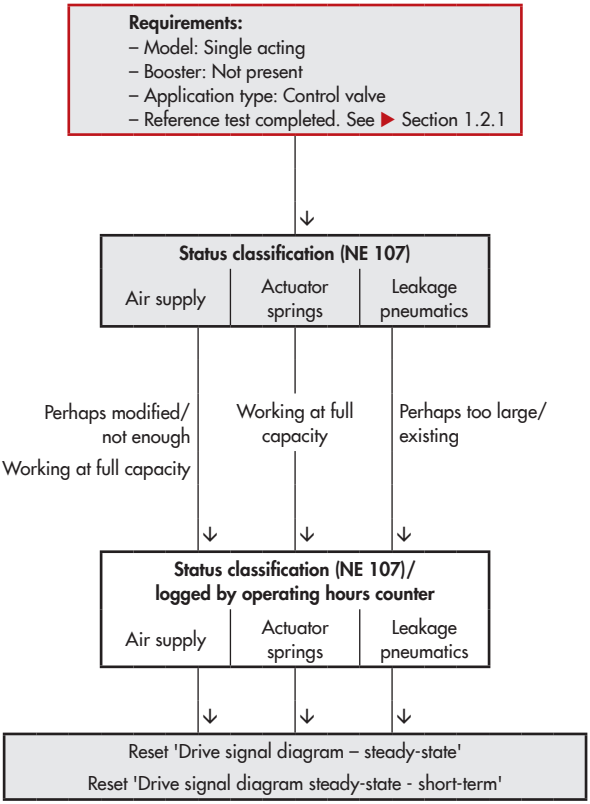
By selecting and executing the "Reset 'Cycle counter histogram" command, all diagnostic parameters and measured data of the histogram and the short-term monitoring as well as the 'Dynamic stress factor' are reset.

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

Diagnosis > Status messages > Reset
– Reset 'Cycle counter histogram'
– Reset 'Cycle counter histogram – short-term'

START-UP

PROCESS



3.6 Drive signal diagram steady-state

The 'Drive signal diagram steady-state' records the drive signal y in relation to the valve position x.

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 p_{out} in the pneumatic actuator, in relation to the valve position.

This test helps pinpoint faults in the supply pressure, pneumatics or actuator springs.

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

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). Each pair of measured values 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.

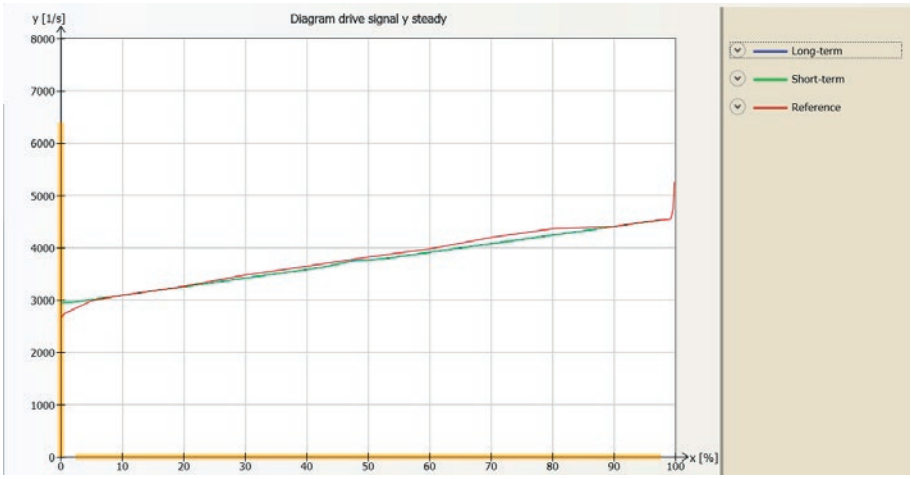


Fig. 6: *Diagnosis > Statistical information > Drive signal diagram > Steady-state*

Note

– *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.*
– *No measured values are recorded if 'Enable set point cutoff decrease' (tight-closing function, Code 14) is active and the valve moves to the value entered in 'Set point cutoff decrease'.*

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 calculated from the last measured values for each valve position class.

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

Requirements

1. A single-acting actuator is mounted on the valve.
2. No booster is mounted on the control valve.
3. The valve operates as a control valve.
4. A reference test has been performed. See ▶ Section 1.2.1.

Settings > Identification > Positioner > Actuator

1. – Model: **Single acting**, [-/-]
   – Booster: **Not present**, [-/-]

Start-up

3. – Application type (Code 49 - h0): **Control valve**

Defining parameters

1. Select classification for status messages.

Settings > Positioner > Error control > Classification report > Extended > ...

1. Air supply
   – Perhaps modified [1]: [⊗], ◆, ⊗, ⚠
   – Perhaps not enough: [⊗], ◆, ⊗, ⚠
   – Working at full capacity: [⊗], ◆, ⊗, ⚠

   Leakage pneumatics
   – Perhaps too large: [⊗], ◆, ⊗, ⚠
   – Perhaps existing: [⊗], ◆, ⊗, ⚠

   Actuator springs
   – Working at full capacity: [⊗], ◆, ⊗, ⚠

3.6.1 Analysis and monitoring

Analysis of the drive signal for control valves starts one hour after the observation period begins. No analysis is performed for on/off valves.

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

– The drive signal runs below the reference as the gradient rises.
– 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 tightened properly or due to a tear in the diaphragm. The positioner generates the 'Leakage pneumatics' message with the selected status classification.
– The drive signal initially follows the course plotted in the reference graph and then starts to rise almost steadily. This pinpoints to a supply pressure that is insufficient for the valve to move through its entire working range. The positioner generates the 'Air supply' message with the selected status classification.
– The drive signal shifts downwards with a smaller gradient than in the reference graph, pinpointing to a reduced spring force in a fail-close control valve. The positioner generates the 'Actuator springs' message with the selected status classification.

Diagnosis > Status messages > Extended

– Air supply: ☑, ◈, ⊗, ⚠
– Leakage pneumatics: ☑, ◈, ⊗, ⚠
– Actuator springs: ☑, ◈, ⊗, ⚠

i Note

The results from the Statistical information test can be checked by performing a test from Tests (out-of-service diagnostics) if the process allows it. See ▶ Section 4.1.

3.6.2 Resetting single status messages

The messages 'Air supply', 'Leakage pneumatics' and 'Actuator springs' are reset by selecting and executing the command "Reset 'Drive signal diagram steady-state" or "Reset 'Drive signal diagram steady-state - short-term".

By selecting and executing the command "Reset 'Drive signal diagram steady-state", all the measured data of the diagram, including the short-term monitoring, are reset.

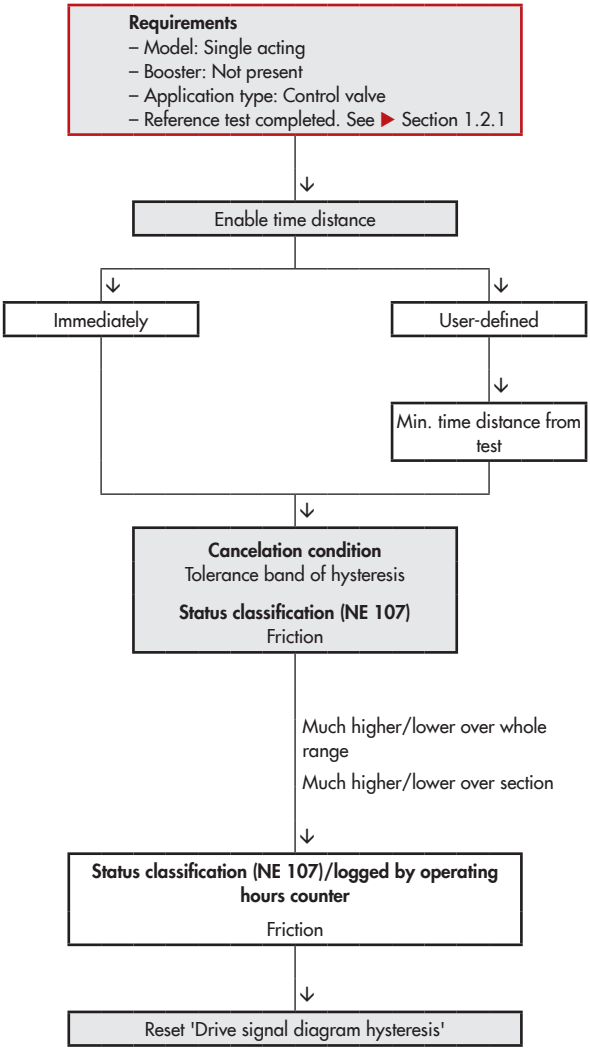
By selecting and executing the command "Reset 'Drive signal diagram steady-state - short-term", the measured data in the **Short-term** folder are reset.

Diagnosis > Status messages > Reset

– Reset 'Drive signal diagram steady-state'
– Reset 'Drive signal diagram steady-state - short-term'

START-UP

PROCESS



3.7 Drive signal diagram hysteresis

The 'Drive signal diagram hysteresis' records the change in drive signal Δy in relation to the valve position x.

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 p_{out} in the pneumatic actuator, in relation to the valve position.

The statistical information 'Drive signal diagram - Hysteresis' allows an analysis in the change of the friction forces.

Data are recorded after the hysteresis test is activated. A single test can be performed immediately or regular tests can be performed after the adjusted time interval has elapsed.

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

- 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 set point cutoff decrease (Code 14): Off
- Enable set point cutoff increase (Code 15): Off
- Required transit time OPEN (Code 21): Variable
- Required transit time CLOSED (Code 22): Variable

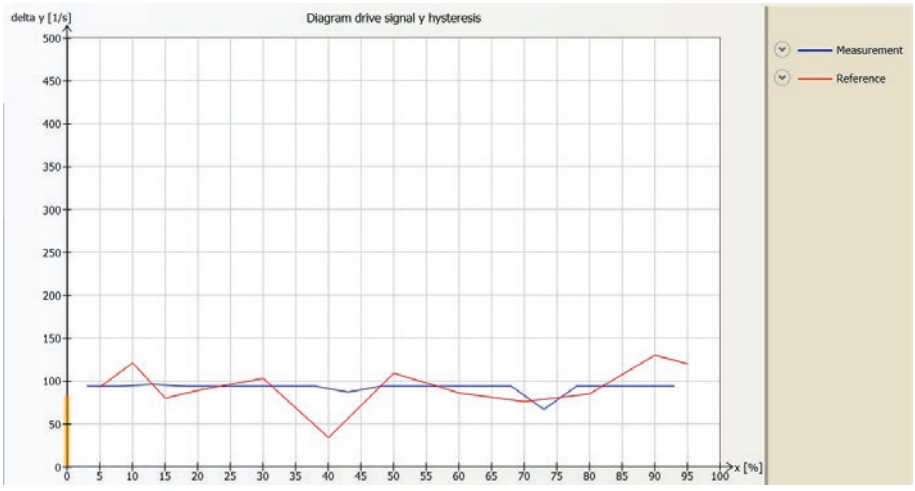


Fig. 7: *Diagnosis > Statistical information > Drive signal diagram > Hysteresis*

Based on the operating point, the test is performed with a change in travel of less than 1 % to find the change in drive signal (Δy). 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 calculated from all the values and plotted in a graph (Measurement).

i ***Note***

– If the test is started in manual mode using the setting 'Enable time distance' = 'User defined' and another test is active at the time selected, the hysteresis test starts 30 seconds after the active test ends.
– A straight line from the average reference data is shown in cases where no data could be compiled for valve working ranges which were not covered by the long-term monitoring.
– If the hysteresis test could not be completed because the valve position is at the top or bottom limit of the working range, the positioner indicates 'Test at operating point not possible' (Test information).

Short-term monitoring

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

Requirements

1. A single-acting actuator is mounted on the valve.
2. No booster is mounted on the control valve.
3. The valve operates as a control valve.
4. A reference test has been performed. See ▶ Section 1.2.1.

Settings > Identification > Positioner > Actuator

1. – Model: **Single acting**, [-/-]
2. – Booster: **Not present**, [-/-]

Start-up

3. – Application type (Code 49 - h0): **Control valve**

Defining parameters

1. Select classification for status messages.
2. Set cancelation condition. See ▶ Section 3.7.1.
3. Define start conditions.
4. Start hysteresis test.
   The 'Test information' status indicates 'Running test'. 'd5' and 'tEST' are indicated in alternating sequence on the positioner display. 'Function check' is activated as the condensed state.

Settings > Positioner > Error control > Classification report > Extended > ...

1. Friction
   – Much higher over whole range: [⊗], ◆, ⊗, ⚠
   – Much lower over whole range: [⊗], ◆, ⊗, ⚠
   – Much higher over section: [⊗], ◆, ⊗, ⚠

– Much lower over section:
[⊗], ◆, ⊗, ⚠

Diagnosis > Statistical information > Drive signal diagram > Hysteresis

2. – Tolerance band of hysteresis: 1 to 5 %, [5 %]
3. – Enable time distance:
[User-defined], Immediately
– Min. time distance from test: 1 to 24 h, [1 h]
4. – Start test.

Note

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

3.7.1 Analysis and monitoring

The test is monitored by the 'Tolerance band of hysteresis' parameter:

– If the valve position x leaves the 'Tolerance band of hysteresis' during the test, the test is immediately canceled and the positioner returns to closed-loop operation.
– If a change in set point (Δw) occurs which is greater than the 'Tolerance band of hysteresis', the test is immediately canceled and the test is started again after waiting 30 seconds using the new operating point.
If this test is also canceled by a change in set point (*Δw)*, it is reactivated after waiting 60 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 canceled for the tenth time, the time entered in 'Min. time distance from test' is kept again.

If the analysis of the hysteresis pinpoints 'Friction' or 'External leakage', the positioner generates a corresponding status message.

Diagnosis > Status messages > Extended

– Friction: ☑, ◆, ⊗, ⚠

Note

The results from the Statistical information test can be checked by performing a test from Tests (out-of-service diagnostics) if the process allows it. See ▶ Section 4.2.

3.7.2 Resetting single status messages

The messages 'Friction' and 'External leakage' are reset by the command "Reset 'Drive signal diagram hysteresis" or "Reset 'Drive signal diagram hysteresis - short-term".

By selecting and executing the command "Reset 'Drive signal diagram hysteresis", all the measured data of the diagram, including the short-term monitoring, are reset.

By selecting and executing the command "Reset 'Drive signal diagram hysteresis - short-term", the measured data in the **Short-term** folder are reset.

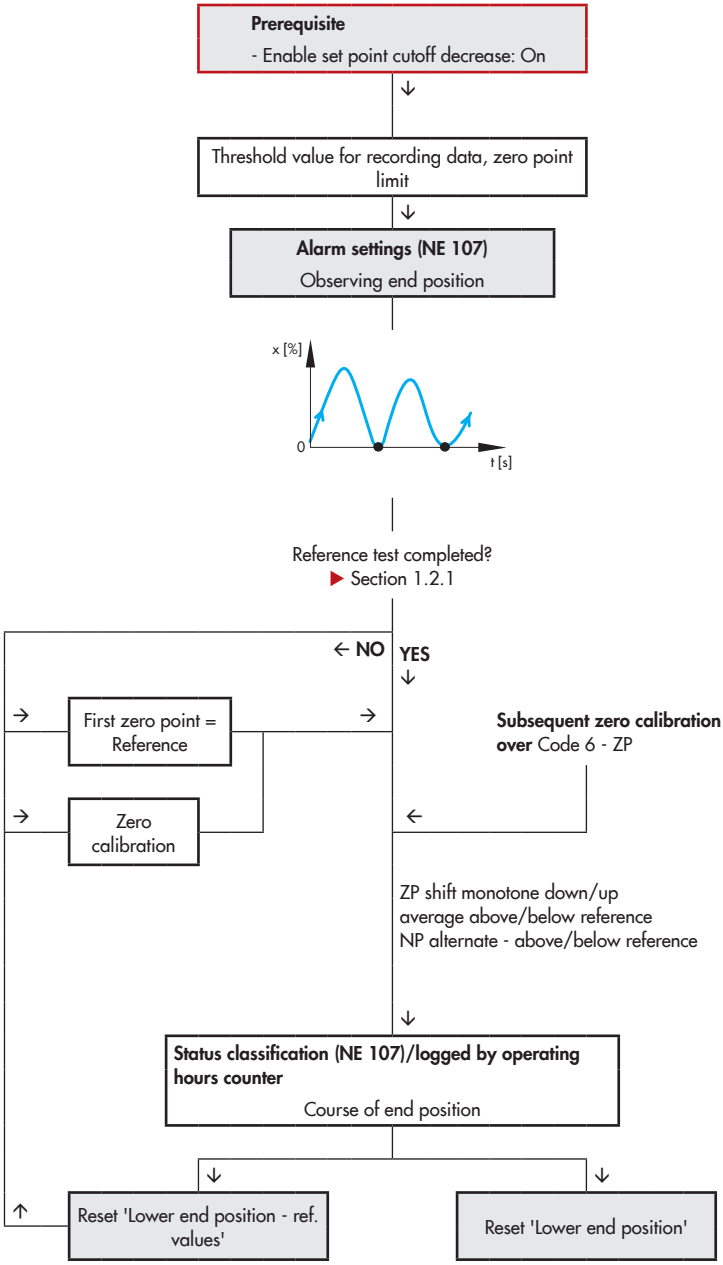
Diagnosis > Status messages > Reset

– Reset 'Drive signal diagram hysteresis'

– Reset 'Drive signal diagram hysteresis - short-term'

START-UP

PROCESS



3.8 Trend of travel end position

The travel end position trend is used to detect an alternating zero point or a creeping zero point shift due to seat and plug wear or dirt between the seat and plug.

Data are recorded in the background regardless of the operating mode selected if the tight-closing function (Code 14) is active. Data logging does not need to be activated.

The course of end position records the valve position x and the drive signal y together with the time stamp by the operating hours counter when the valve moves to the lower end position. The new recorded valve position is compared to the last saved zero point. If it differs by the 'Threshold value for recording data' from the last value, the data of the new zero point are saved.

A graph of the recorded valve positions at the lower end position is plotted over the number of measurements.

The positioner saves the valve positions in a circular buffer, which holds 30 measured values at one time. The recorded measured data are listed in the **Lower end position** folder.

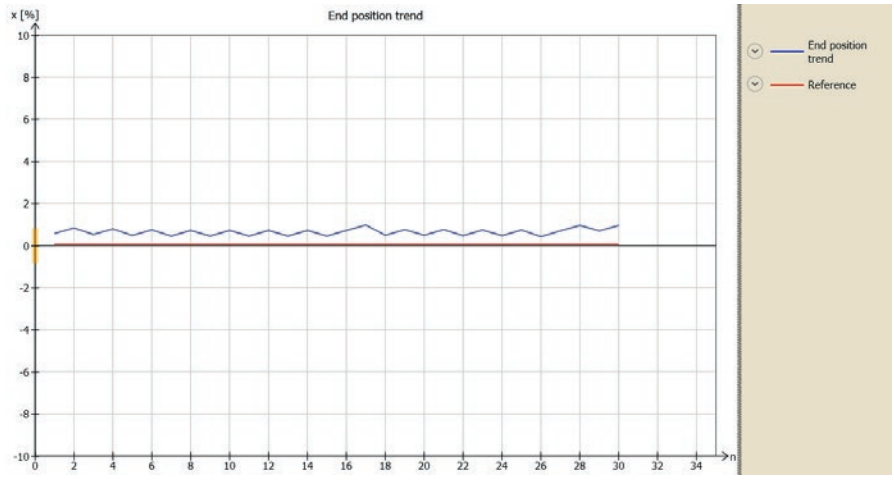


Fig. 8: *Diagnosis > Statistical information > Trend of travel end position*

Defining parameters

1. Activate tight-closing function.
2. Set conditions for saving reference value and zero point. See ▶ Section 3.8.1.
3. Select classification for status messages.

Settings > Positioner > Reference variable

1. – Enable set point cutoff decrease (Code 14): **[On]**
   – Set point cutoff decrease (Code 14): 0.0 to 49.9 %, [1.0 %]

Diagnosis > Statistical information > Trend of travel end position

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

Settings > Positioner > Error control

– Zero point limit (Code 48 - d5): 0.0 to 100.0 %, [5.0 %]

Settings > Positioner > Error control > Classification report > Extended > ...

3. Observing end position
   – Zero point - shift monotone down; average above reference: [⊗], ◈, ⊗, ⚠
   – Zero point - shift monotone up; average above reference: [⊗], ◈, ⊗, ⚠
   – Zero point - alternate; average above reference: [⊗], ◈, ⊗, ⚠
   – Zero point - shift monotone down; average below reference: [⊗], ◈, ⊗, ⚠
   – Zero point - shift monotone up; average below reference: [⊗], ◈, ⊗, ⚠
   – Zero point - alternate; average below reference: [⊗], ◈, ⊗, ⚠

3.8.1 Analysis and monitoring

Analysis of the histogram starts directly after the change to manual or automatic mode.

A reference zero point must be recorded to analyze the end position trend. This is recorded during the reference test (see ▶ Section 1.2.1). In case a reference test has not been performed, the first zero point that the valve moved to serves as the reference value. The reference value is represented by a straight line in the end position graph.

i Note

If the reference value has been reset by selecting and executing "Reset 'Lower end position - ref. values" (see ▶ Section 2.2.1), the first zero point that the valve moves to after the reset serves as the new reference value, provided it does not exceed the 'Zero point limit'.

If the analysis of end position trend pinpoints a fault, the positioner generates the 'Observing end position' message with the selected status classification.

Diagnosis > Status messages > Extended

– Observing end position: ☑, ◈, ⊗, ⚠

3.8.2 Resetting single status messages

The 'Observing end position' message and the measured data of the end position trend are reset by the command "Reset 'Lower end position".

If only the reference zero point is to be reset, select and execute "Reset 'Lower end position - Ref. values".

Diagnosis > Status messages > Reset

– Reset 'Lower end position'

– Reset 'Lower end position - ref. values'

– 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 set point cutoff decrease (Code 14): Off
– Enable set point 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 Tests

For reasons of safety, these tests can only be started when the positioner is in the manual mode.

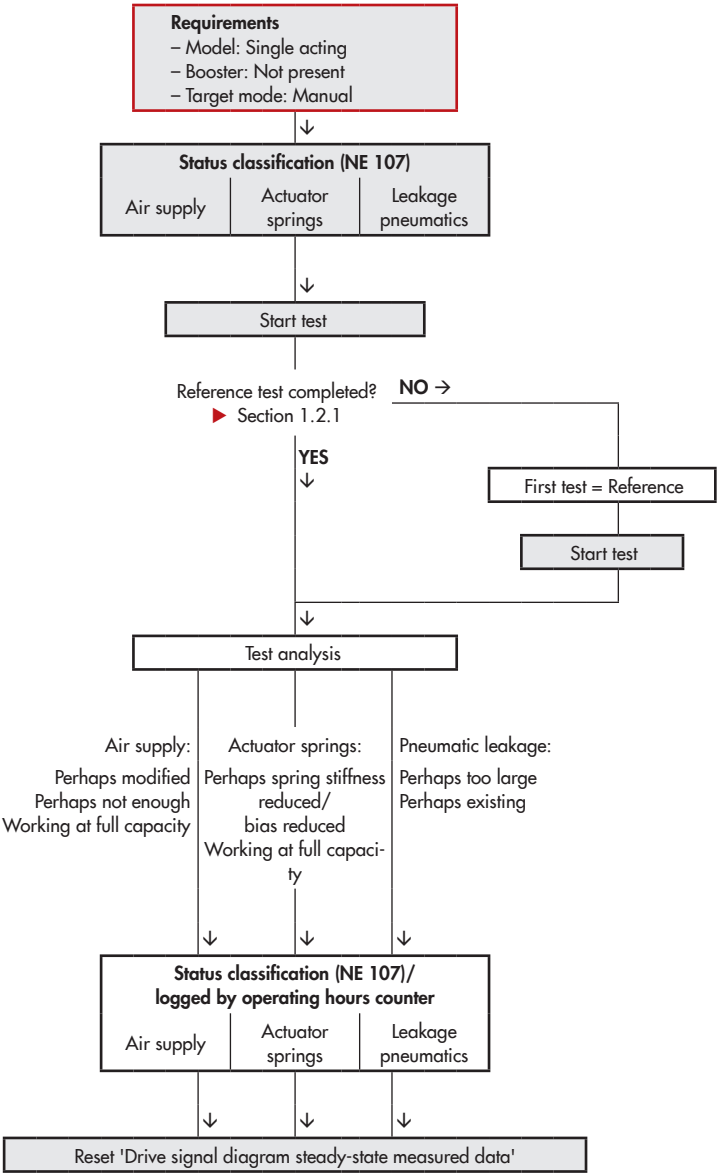
! NOTICE

The control valve moves through its defined working range while a test is being performed. Therefore, it is important to check before starting a test whether the conditions (in the plant or process) allow the valve to move through its working range.

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 parameters are briefly changed while the tests are running:

START-UP

MANUAL MODE (TEST)



4.1 Drive signal diagram steady-state

The 'Drive signal diagram steady-state' (Tests) allows you to check the results of the drive signal diagram steady-state in Statistical information (in-service monitoring) more closely (see ▶ Section 3.6). Besides pinpointing problems in supply pressure, it can also detect defective actuator springs.

The test is started in the manual mode.

During the test the valve moves to various fixed valve positions 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).

Requirements

1. A single-acting actuator is mounted on the valve.
2. No booster is mounted on the control valve.
3. A reference test has been performed. See ▶ Section 1.2.1.
   If a reference test has not be stored in the positioner, the data of the first test performed are used as the reference.

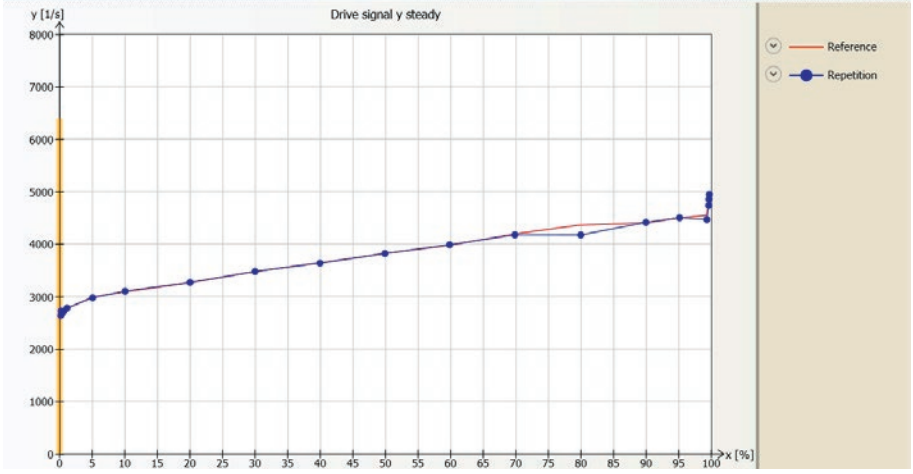


Fig. 9: *Diagnosis > Tests > Drive signal diagram steady-state*

Settings > Identification > Positioner > Actuator

1. – Model: **Single acting**, [-/-]
2. – Booster: **Not present**, [-/-]

Defining parameters

1. Switch to manual mode.
2. Select classification for status messages.
3. Start test.
   The 'Test information' status indicates 'Running test'. 'd1' and 'tEST' are indicated in alternating sequence on the positioner display.
   'Function check' is activated as the condensed state.

Operation > Operating mode [1)]

1. Target mode (Code 0): Manual

Settings > Positioner > Error control > Classification report > Extended > ...

2. Air supply
   – Perhaps modified (TEST): [⊗], ◆, ⊗, ⚠
   – Perhaps not enough (TEST): [⊗], ◆, ⊗, ⚠
   – Working at full capacity (TEST): [⊗], ◆, ⊗, ⚠

   Leakage pneumatics
   – Perhaps existing (TEST): [⊗], ◆, ⊗, ⚠
   – Perhaps too large (TEST): [⊗], ◆, ⊗, ⚠

   Actuator springs
   – Perhaps spring stiffness reduced (TEST) [⊗], ◆, ⊗, ⚠
   – Perhaps bias reduced (TEST): [⊗], ◆, ⊗, ⚠
   – Working at full capacity (TEST): [⊗], ◆, ⊗, ⚠
3. Start test

i Note

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 canceled, the positioner remains in manual mode.

In TROVIS-VIEW the test information and progress flag of the test are displayed. The 'Test information' status indicates 'Test finished' after the test is finished.

i Note

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

4.1.1 Analysis and monitoring

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

– The drive signal runs below the reference as the gradient rises.
– 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 tightened properly or due to a tear in the diaphragm. The positioner generates the 'Leakage pneumatics' message with the selected status classification.
– The drive signal initially follows the course plotted in the reference graph and then starts to rise almost steadily. This pinpoints to a supply pressure that is insufficient for the valve to move through its entire working range. The positioner generates the 'Air supply' message with the selected status classification.
– The drive signal shifts downwards with a smaller gradient than in the reference graph, pinpointing to a reduced spring force in a fail-close control valve. The positioner generates the 'Actuator springs' message with the selected status classification.

Diagnosis > Status messages > Extended

– Air supply: ☑, ◈, ⊗, ⚠
– Leakage pneumatics: ☑, ◈, ⊗, ⚠
– Actuator springs: ☑, ◈, ⊗, ⚠

4.1.2 Resetting single status messages

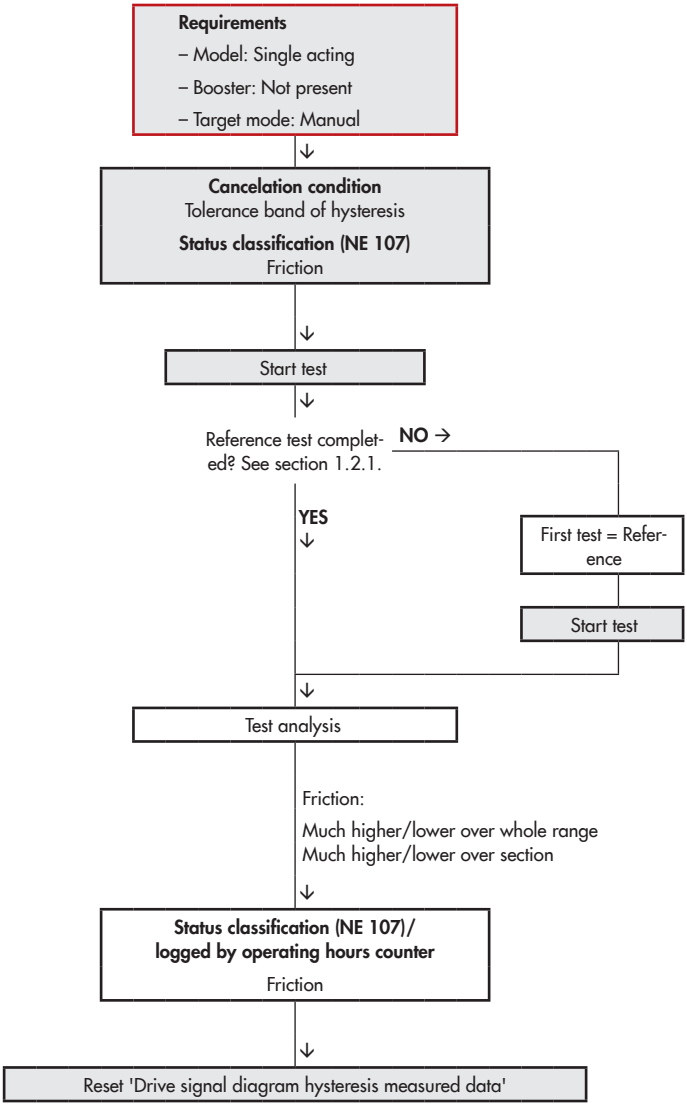
The diagnostic parameters and measured data analysis from the 'Drive signal diaphragm steady-state' test are reset by selecting and executing the command "Reset 'Drive signal diagram steady-state measured data".

Diagnosis > Status messages > Reset

– Reset 'Drive signal diagram steady-state measured data'

START-UP

MANUAL MODE (TEST)



4.2 Drive signal diagram hysteresis

The 'Drive signal diagram hysteresis' (Tests) allows you to check the results of the drive signal diagram hysteresis in Statistical information (in-service monitoring) more closely (▶ Section 3.7). Changes in friction can be detected.

The test is started in the manual mode.

During the test the valve moves to various fixed valve positions distributed over the working range of the valve. After moving to each valve position, a ramp movement changing the valve travel by less than 1 % is performed. The change in drive signal (Δy) is measured for each valve position x and compared with the reference data. The recorded data of the change in drive signal (Δy) are plotted versus the valve position x in a graph.

Requirements

1. A single-acting actuator is mounted on the valve.
2. No booster is mounted on the control valve.
3. A reference test has been performed. See ▶ Section 1.2.1.
   If a reference test has not be stored in the positioner, the data of the first test performed are used as the reference.

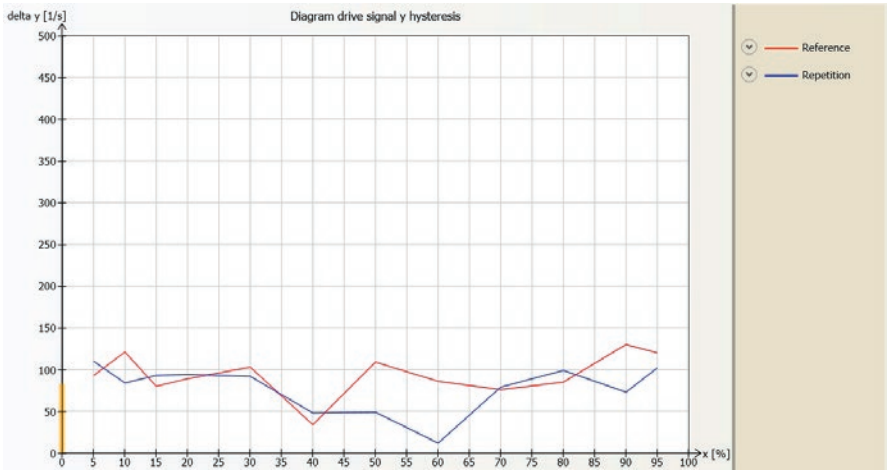


Fig. 10: *Diagnosis > Tests > Drive signal diagram hysteresis*

Settings > Identification > Positioner > Actuator

1. – Model: **Single acting**, [-/-]
2. – Booster: **Not present**, [-/-]

Defining parameters

1. Switch to manual mode.
2. Select classification for status messages.
3. Set cancelation condition. See ▶ Section 4.2.1.
4. Start test.
   The 'Test information' status indicates 'Running test'. 'd2' and 'tEST' are indicated in alternating sequence on the positioner display.
   'Function check' is activated as the condensed state.

Operation > Operating mode

1. – Target mode (Code 0): Manual

Settings > Positioner > Error control > Classification report > Extended > ...

2. Friction
   – Much higher/lower over whole range (TEST) [2]: [⊗], ◆, ⊗, ⚠
   – Much higher/lower over section (TEST) [2]: [⊗], ◆, ⊗, ⚠

Diagnosis > Statistical information > Drive signal diagram > Hysteresis

3. – Tolerance band of hysteresis: 1.0 to 5 %, [5 %]

Diagnosis > Tests > Drive signal diagram hysteresis

4. – Start test

i Note

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 canceled, the positioner remains in manual mode.

In TROVIS-VIEW the test information and progress flag of the test are displayed. The 'Test information' status indicates 'Test finished' after the test is finished.

4.2.1 Analysis and monitoring

The test is canceled if the valve cannot move to a certain position or a value leaves the 'Tolerance band of hysteresis'.

– If the valve position x leaves the 'Tolerance band of hysteresis' during the test, the test is immediately canceled and the positioner returns to closed-loop operation.
– If a change in set point (Δw) occurs which is greater than the 'Tolerance band of hysteresis', the test is immediately canceled and the test is started again after waiting 30 seconds using the new operating point.
– If this test is also canceled by a change in set point (*Δw)*, it is reactivated after waiting 60 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

tenth time that the test is canceled, the time entered in 'Min. time distance from test' is kept again.

If the analysis of the hysteresis pinpoints 'Friction', the positioner generates a corresponding status message.

Diagnosis > Status messages > Extended

– Friction: 

4.2.2 Resetting single status messages

The diagnostic parameters and measured data analysis from the 'Drive signal diaphragm hysteresis' test are reset by selecting and executing the command "Reset 'Drive signal diagram hysteresis measured data".

Diagnosis > Status messages > Reset

– Reset 'Drive signal diagram hysteresis measured data'

4.3 Static characteristic

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

The test is started in the manual mode.

The positioner specifies the set point w in a defined test range ('Start' and 'End') in small steps and records the response of the valve position x after waiting a '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 set point (Δw) is plotted in a graph.

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

- 'Min. dead band': Minimum change in set point that causes a minimal change in the valve position.
- 'Average dead band': Average change in set point that causes a minimal change in the valve position.
- 'Max. dead band': Maximum change in set point that causes a minimal change in the valve position.

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

Defining parameters

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

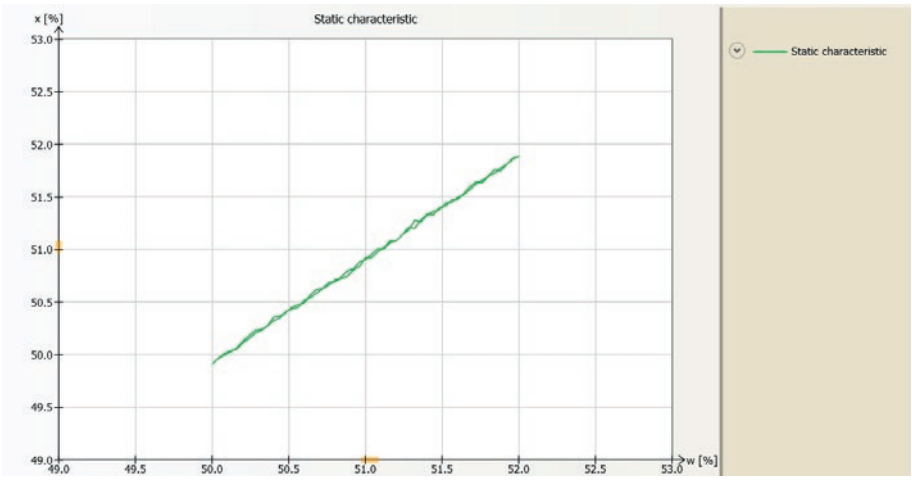


Fig. 11: *Diagnosis > Tests > Static characteristic*

The 'Test information' status indicates 'Test active'. 'd3' and 'tEST' are indicated in alternating sequence on the positioner display. 'Function check' is activated as the condensed state.

Operation > Operating mode

1. – Target mode (Code 0): Manual

Diagnosis > Tests > Static characteristic

2. – 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]
3. – Start test

i ***Note***

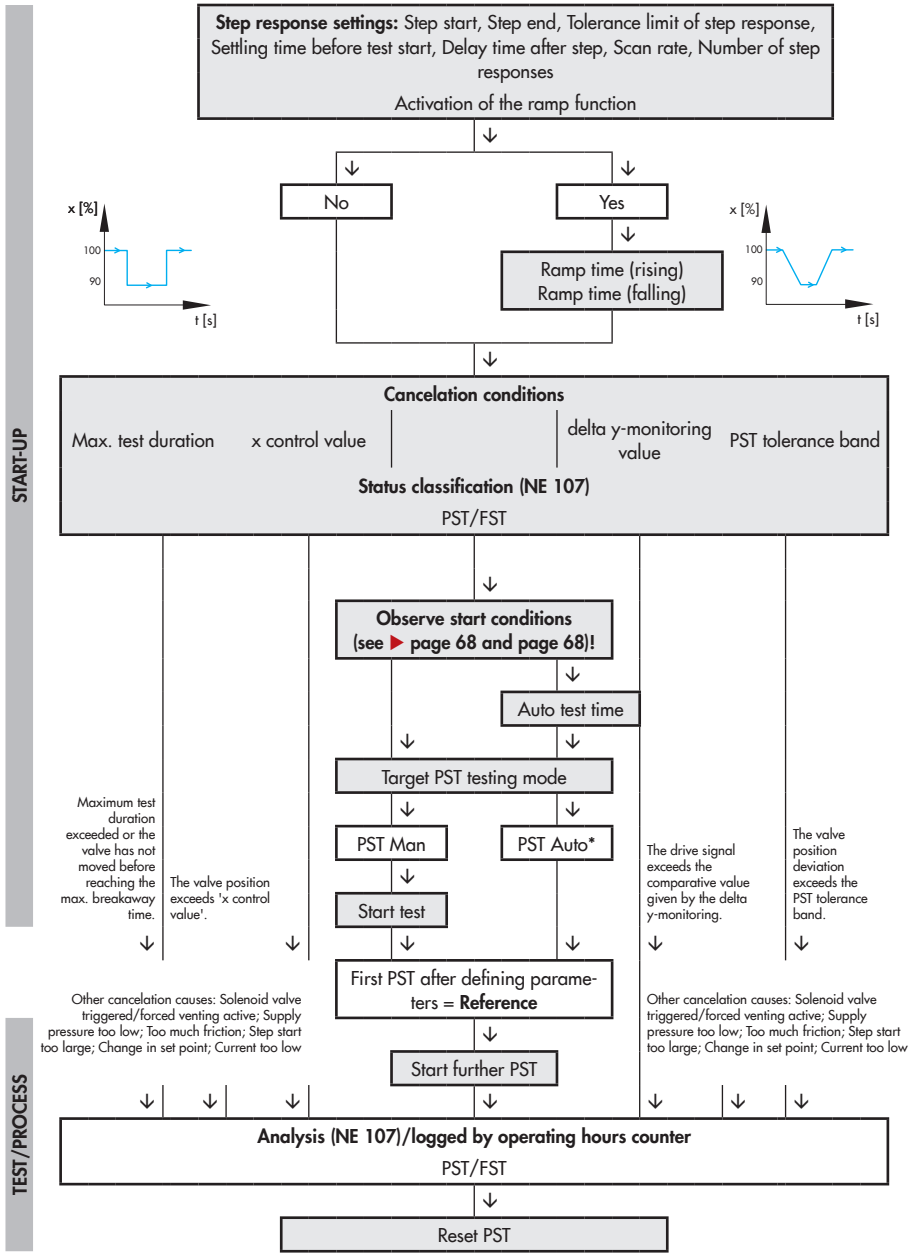
Cancel the test by right-clicking 'Stop test' and selecting 'Execute' or by pressing the rotary pushbutton at the positioner.

After the test has been canceled, the positioner remains in manual mode.

In TROVIS-VIEW the test information and progress flag of the test are displayed. The 'Test information' status indicates 'Test not active' after the test is finished.

4.3.1 Resetting single status messages

A single reset of diagnostic parameters and measured data is not possible.



* **Note!** The positioner is write-protected when tests are performed according to a schedule (local operation and operating software).

4.4 Partial stroke test (PST)

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

A shut-off valve normally in its end position can be prevented from seizing up or getting jammed. The breakaway torque must be overcome when the plug starts to move out of its open position. This breakaway torque depends on the seal, deposits on the seat and plug, the process medium and friction in the valve trim. After the breakaway torque has been overcome, it can be assumed that the valve is able to completely close.

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

The partial stroke test can be performed once (test immediately started) or, with an on/off valve in automatic mode, regularly (time-controlled), provided the start conditions are met (see ▶ Table 4):

– A control valve is in the manual mode.
– An on/off valve is in the manual or automatic mode. In automatic mode, the test is only started when the Set point w is greater than the 'Limit fail-safe position' (Code 49 - h2).

The following listed parameters are changed as specified below while the partial stroke test is being performed:

– Characteristic selection (Code 20): Linear

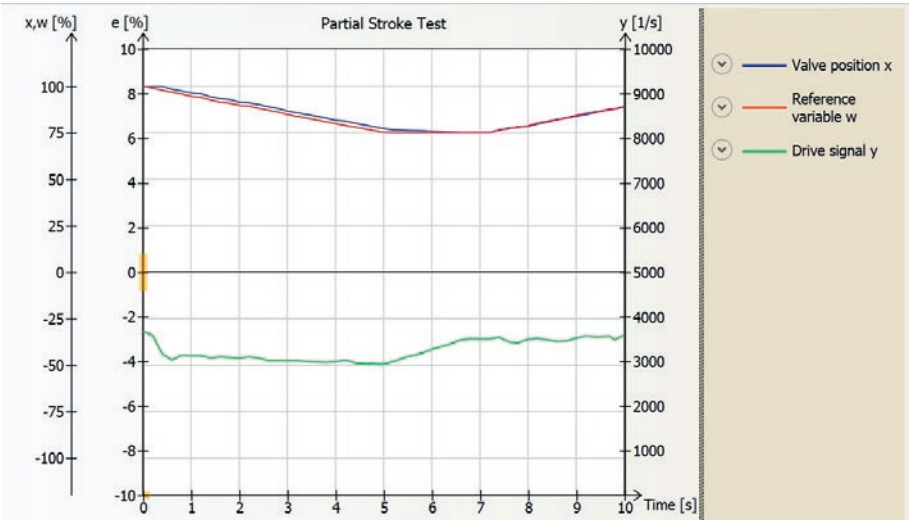


Fig. 12: *Diagnosis > Tests > Partial stroke test*

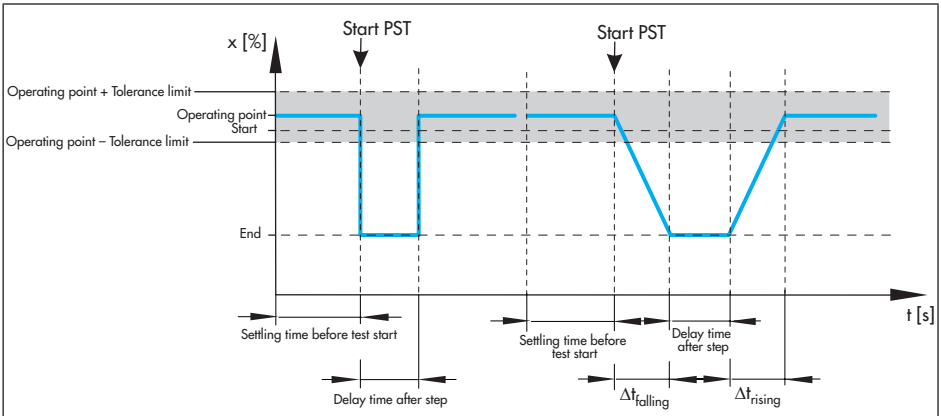
– Required transit time OPEN (Code 21): Variable
– Required transit time CLOSED (Code 22): Variable

During the partial stroke test, the valve moves from its current 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. 13). For the test in a ramp function, additionally the ramp times for the rising and falling ramps need to be defined.

The PST diagnostic parameter 'Step start' must be within the range of the current operating point ± 'Tolerance limit of step response' for the partial stroke test to start.

After being activated, the test does not start until the 'Settling time before test start' has elapsed. Starting from the 'Step start', the valve moves to 'Step end'. The valve remains in this position for the time defined by the 'Delay time after step' before performing a second step change in the opposite direction from 'Step end' to 'Step start'. After the 'Delay time after step' has elapsed, the valve moves back to its operating point.



$$\Delta t_{falling} \quad \frac{\text{'Step start'} - \text{'Step end'}}{100} \quad x \quad \text{'Ramp time (falling)'}$$

$$\Delta t_{rising} \quad \frac{\text{'Step start'} - \text{'Step end'}}{100} \quad x \quad \text{'Ramp time (rising)'}$$

Fig. 13: *Course of the partial stroke test with step response (left) and ramp function (right)*

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

Test cancelation conditions

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

The positioner cancels when one of the following cancelation conditions is fulfilled:

– 'Max. test duration': The test is canceled when the maximum permissible test duration is reached.

Cancelation condition - valve position x (to check the valve position)

– 'x control value': The test is canceled as soon as the valve position falls below the adjusted value.
  This cancelation condition only becomes effective after it has been activated ('Activation x control' = Yes).

Cancelation condition - drive signal y (to monitor the friction of the plug)

A higher drive signal from the positioner is caused by increased plug friction and the resulting increased breakaway torque. This may result in overshooting. To prevent this, the drive signal y can be monitored and the test canceled in the event that an error is detected.

– 'delta y-monitoring value': The test is canceled as soon as the drive signal y falls below or exceeds the reference value. The reference value is made up of the diagnostic parameters ''delta y-monitoring reference value' and 'delta y-monitoring value'. The 'delta y-monitoring value' is entered in % and is based on the entire drive signal range (10000 ⅛). This cancelation condition only becomes effective after it has been activated ('Activation delta y-monitoring' = Yes).
– This cancelation condition only becomes effective when the full actuator thrust is required to move the valve due to the process conditions.

i Note

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

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

– 'Aborted by int. solenoid valve/forced venting': The test was canceled by the activation of the solenoid valve/forced venting function.
– 'Supply pressure/friction': An insufficient supply pressure or excessive friction occurred during the test.
– 'Difference w - step start too high': The 'Step start' is outside the range of operating point ± 'Tolerance limit of step response'.

– 'Reference variable was changed': The test was started according to a schedule (time-controlled). Due to a set point change before the step was started, the 'Step start' is outside the range of the operating point ± 'Tolerance limit of step response'.
– 'Current too low'

i Note

The 'Measured data storage out of memory' reading (Maintenance alarm) is generated when the 'Scan rate' is too low. After recording 100 measured values per variable, logging is stopped, but the test continues until it is completed.

After the partial stroke test is canceled, the 'Status of partial stroke test' reading indicates 'Not successful'. The reason for cancelation is marked by the 'Maintenance alarm' message in the **Analysis of measured data** folder (> Current test).

Defining parameters

1. Define parameters for partial stroke test. See ▶ Note concerning setting the PST diagnostic parametersetting the PST diagnostic parameters on page 69.
2. Define parameters for cancelation conditions.
3. Select classification for status message.
4. Start the partial stroke test.
   The 'Test information' status indicates 'Test active'. 'd4' and 'tEST' are indicated in alternating sequence on the positioner display. 'Function check' is activated as the condensed state.

Diagnosis > Tests > Partial stroke test

1. – Step start (Code 49 - d2): 0.0 to [100.0 %]
   – 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): Yes, [No]
   – Settling time before test start (Code 49 - d7): 1 to 240 s, [1 s]
   – Delay time after step (Code 49 - d8): 1.0 to 240.0 s, [2.0 s]
   – Scan rate (Code 49 - d9): 0.2 to 250.0 s, [0.8 s]
   – Number of step responses: 1, [2]

   Only when the ramp function is activated:
   – Ramp time (falling) (Code 49 - d5): 0 to 9999 s, [600 s]
   – Ramp time (rising) (Code 49 - d6): 0 to 9999 s, [60 s]

2. – Max. test duration (Code 49 - E7): 30 to 25000 s, [90 s]
   – Max. breakaway time: 0.0 to 25000.0 s, [7.5 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 (Code 49 - A8): Yes, [No]
   – delta y-monitoring value (Code 49 - A9): 0 to 100 %, [0 %]

– Activation PST tolerance band control (Code 49 - E5): Yes, [No]

– PST tolerance band (Code 49 - E6): 0.1 to 100.0 %, [5.0 %]

Settings > Positioner > Error control > Classification report > Extended > PST/FST

3. – PST/FST - Status active: ⊗, [◈], ⊗, ⚠

Diagnosis > Tests > Partial stroke test

4. **Either:**

– Target PST testing mode (Code 49 - A2): **[PST Man]**

– Start test

Or: (with a control valve only in manual mode (MAN), with an on/off valve only in automatic mode (AUTO))

– Target PST testing mode (Code 49 - A2) = **PST Auto**, [PST Man]

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

NOTICE

The positioner is write-protected when tests are performed according to a schedule (local operation and operating software).
Code 0 reading: "OC" and "PST" in alternating sequence
Code 3 reading: "PST" blinks.

Note

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 canceled, the positioner remains in selected mode. The 'Status of partial stroke test' reading indicates 'Not successful'.

In TROVIS-VIEW the test information and progress flag of the test are displayed. The 'Test information' status indicates 'Test not active' after the test is finished.

Note concerning setting the PST diagnostic parameters

– We recommend only to start the partial stroke test when the valve is in the end position. In on/off valves, the start value must be the same as the operating point.

– The 'Ramp time (rising)' must be greater than the corresponding value for 'Minimum transit time close' (Code 41) determined during initialization.

– The 'Ramp time (falling)' must be greater than the corresponding value for 'Minimum transit time open' (Code 40) determined during initialization.

Tip

Users with expert knowledge of valve diagnostics can determine appropriate ramp times by performing a full stroke test. See ▶ Section 7.4.

– The 'Scan rate' must not be lower than the indicated 'Min. recommended scan rate'. The 'Min. recommended scan rate' is calculated from the 'Duration of the test'.

4.4.1 Start triggered by the set point

The partial stroke test of on/off valves is triggered when the set point w moves in the range between 25 and 50 % of the travel and remains there for longer than six seconds. See ▶ Section 3.1.

'Step start' must be within the range of the defined position ± 'Tolerance limit of step response' for the partial stroke test to start.

The test and its cancelation are described in ▶ Section 4.4, while the test assessment is described in ▶ Section 4.4.3.

4.4.2 Start triggered by the binary input

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

– A control valve is in the manual mode.
– An on/off valve is in the manual or automatic mode. In automatic mode, the test is only started when the 'Fail-safe reference value' is greater than the 'Limit fail-safe position' (Code 49 - h2). In manual mode, the test is only started when 'Target PST testing mode' = 'PST Man'.

The test and its cancelation are described in ▶ Section 4.4, while the test assessment is described in ▶ Section 4.4.3.

It is important to make sure that the diagnostic parameter 'Step start' of the partial stroke test is within the range of the 'Fail-safe reference value' ± 'Tolerance limit of step response'.

Settings > Positioner > Options

– Action at active binary input: Start partial stroke test (PST)
– Edge control binary input: [On: open switch/Off: closed switch], On: closed switch/Off: open switch
– Fail-safe reference value: 0.0 to 100.0 %, [50.0 %]
– Configuration binary input: [Active], Passive

i Note

Further details on optional binary input ▶ Section 6.

4.4.3 Analysis and monitoring

The analysis of the last three partial stroke tests are saved with a time stamp in the **Analysis of measured data** folder. A graph of the last partial stroke test is shown in the **Partial stroke test** folder.

Test completed successfully

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

Analysis of measured data (step response test):

– 'Overshoot' (relative to the step height) [%]
– 'Dead time' [s]
– 'T63' [s]

– 'T89' [s]
– 'Rise time' [s]
– 'Settling time' [s]

Analysis of measured data (ramp test):

– 'Overshoot' (relative to the step height) [%]

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

Note

Changes in the diagnostic parameters listed below affect the test. The results of the next following partial stroke test are used as the new reference measurement:

– 'Step start'
– 'Step end'
– 'Activation of the ramp function'
– 'Ramp time (rising)'
– 'Ramp time (falling)'
– 'Delay time after step'

Test not completed

If the test was not completed, the reason for cancelation is indicated in the corresponding reading by the 'Maintenance alarm' message. The positioner generates a 'PST/FST' message with the selected status classification. 'Extended diagnosis' (Code 79) is activated regardless of the status classification.

Diagnosis > Status messages > Extended

PST/FST: 

Note

The 'No test available' status remains active until a partial stroke test is completed successfully.

4.4.4 Resetting single status messages

The diagnostic parameters and measured data analysis of the partial stroke test are reset by selecting and executing the command 'Reset PST'.

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

Diagnosis > Status messages > Reset

– Reset PST

4.4.5 Step response

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:

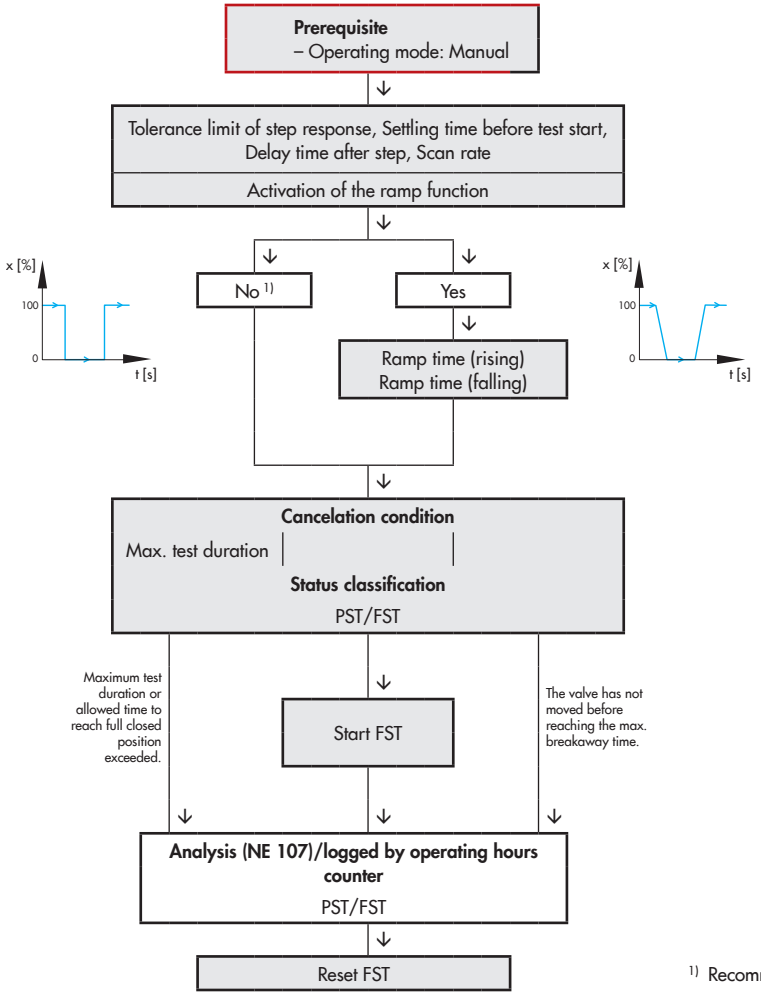
– Deactivate all cancelation conditions of the partial stroke test, providing the process allows it.

Table 4: *Start options for the partial stroke test (PST)*

Application type	PST start by / Operating mode	**Rotary pushbutton or operating software** See page 65 Manual	**Test interval (time-controlled)** See page 65 Automatic	**Set point w** See section 4.4.1 Automatic	**Binary input** See section 4.4.2 Automatic
Control valve	Automatic mode AUTO	Not possible	Not possible	–	Not possible
	Manual mode MAN	Possible	Not possible	–	Possible
On/off valve	Automatic mode AUTO	Possible	Possible	Possible	Possible
	Manual mode MAN	Possible	Possible	Not possible	Possible
Triggering event		Code 49 - A0 = YES or 'Start test' parameter activated	'Auto test time' elapsed	Set point is six seconds long in the range between 25 and 50 % of travel	Binary input changes to 'On: open switch' or 'Off: closed switch' (see 'Edge control binary input' parameter)

START-UP

Manual mode (TEST)



1) Recommended

4.5 Full stroke test (FST)

The dynamic valve performance can be evaluated by performing the test.

The full stroke test is started in the manual mode.

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

– Characteristic selection (Code 20): Linear
– Required transit time OPEN (Code 21): Variable
– Required transit time CLOSED (Code 22): Variable

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

The first step ends in the fail-safe position. As a result, 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. 15). For the test in a ramp function, additionally the times 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' has elapsed. This ensures that the valve has reached the start position.

Starting from the start position, the valve moves to the fail-safe position. The valve remains in this position for the time defined by the 'Delay time after step' 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' has elapsed, the valve moves back to its operating point.

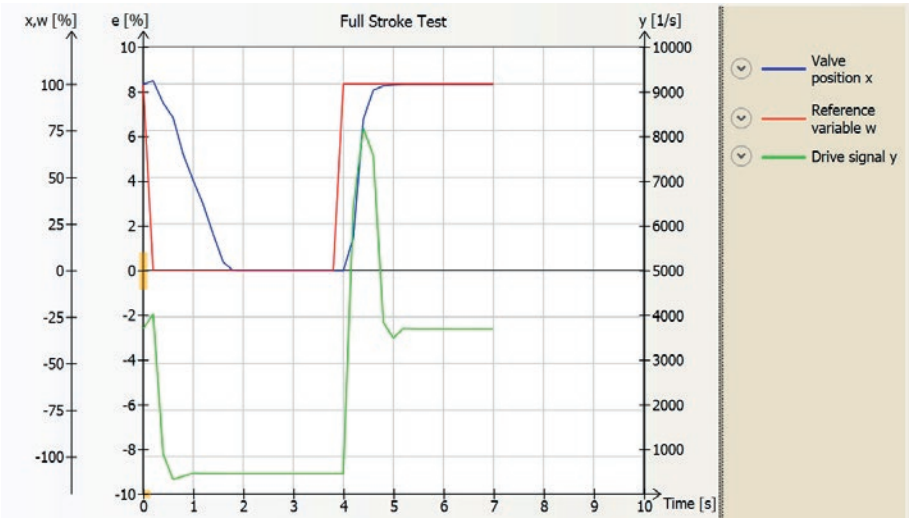


Fig. 14: *Diagnosis > Tests > Full stroke test*

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

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

Test cancelation conditions

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

– 'Max. test duration': The test is canceled when the maximum permissible test duration is reached.

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

– 'Aborted by int. solenoid valve/forced venting': The test was canceled by the activation of the solenoid valve/forced venting function.

– 'Supply pressure/friction': An insufficient supply pressure or excessive friction occurred during the test.

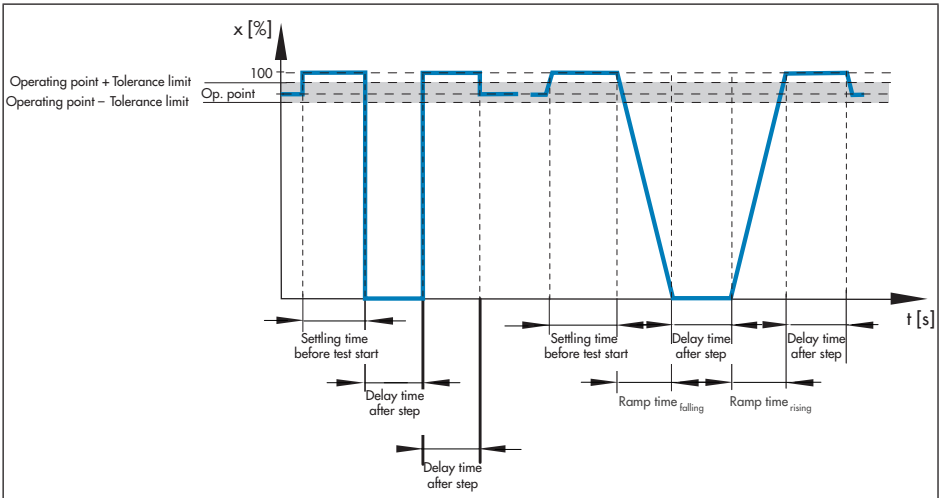


Fig. 15: *Course of the full stroke test with step response (left) and ramp function (right)*

Note

The 'Measured data storage out of memory' reading (Maintenance alarm) is generated when the 'Scan rate' is too low. After recording 100 measured values per variable, logging is stopped, but the test continues until it is completed.

After the full stroke test is canceled, the 'Status of full stroke test' reading indicates 'Not successful'. The reason for cancelation is marked by the 'Maintenance alarm' message in the **Analysis of measured data** folder (> Current test).

Defining parameters

1. Switch to manual mode.
2. Define parameters for full stroke test. See ▶ Note concerning setting the FST diagnostic parameters on page 77.
3. Configure the cancelation conditions.
4. Select classification for status message.
5. Start full stroke test.
   The 'Test information' status indicates 'Test active'. 'd6' and 'tEST' are indicated in alternating sequence on the positioner display. 'Function check' is activated as the condensed state.

Operation > Operating mode

1. – Target mode (Code 0): Manual

Diagnosis > Tests > Full stroke test

2. – Tolerance limit of step response: 0.1 to 10.0 %, [2.0 %]
   – Activation of the ramp function: [Yes], No
   – Settling time before test start: 1 to 240 s, [10 s]
   – Delay time after step: 2.0 to 100.0 s, [2.0 s]
   – Scan rate: 0.2 to 250.0 s, [1.4 s]

   Only when the ramp function is activated:
   – Ramp time (rising): 0 to 9999 s, [60 s]
   – Ramp time (falling): 0 to 9999 s, [60 s]
3. – Max. test duration: 30 to 25000 s, [150 s]

Settings > Positioner > Error control > Classification report > Extended > PST/FST

4. – PST/FST - Status active: ⊗, [◈], ⊗, ⚠

Diagnosis > Tests > Full stroke test

5. – Start test

Note

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 canceled, the positioner remains in manual mode.

Note concerning setting the FST diagnostic parameters

– The 'Ramp time (rising)' must be greater than the corresponding value for 'Minimum transit time close' (Code 41) determined during initialization.
– The 'Ramp time (falling)' must be greater than the corresponding value for 'Minimum transit time open' (Code 41) determined during initialization.

– The 'Scan rate' must not be lower than the indicated 'Min. recommended scan rate'. The 'Min. recommended scan rate' is calculated from the 'Duration of the test'.

4.5.1 Analysis and monitoring

The analysis of the last three full stroke tests are saved with a time stamp in the **Analysis of measured data** folder.

Test completed successfully

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

Analysis of measured data (step response test):

– 'Overshoot' (relative to the step height) [%]
– 'Dead time' [s]
– 'T63' [s]
– 'T89' [s]
– 'Rise time' [s]
– 'Settling time' [s]

Analysis of measured data (ramp test):

– 'Overshoot' (relative to the step height) [%]

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

Note

Changes in the diagnostic parameters listed below affect the test. The results of the next following full stroke test are used as the new reference measurement:

– 'Activation of the ramp function'
– 'Ramp time (rising)'
– 'Ramp time (falling)'
– 'Delay time after step'

Test not completed

If the test was not completed, the reason for cancelation is indicated in the corresponding reading by the 'Maintenance alarm' message. The positioner generates a 'PST/FST' message with the selected status classification. 'Extended diagnosis' (Code 79) is activated regardless of the status classification.

Diagnosis > Status messages > Extended

– PST/FST:


Note

The 'No test available' status remains active until a full stroke test is completed successfully.

4.5.2 Resetting single status messages

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

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

Diagnosis > Status messages > Reset
Reset FST

5 Dynamic HART® variables

The HART® specification defines four dynamic variables consisting of a value and an engineering unit. These variables can be assigned to device parameters as required. The universal HART® command 3 reads the dynamic variables out of the device. This allows manufacturer-specific parameters to also be transferred using a universal command.

Depending on the positioner, the dynamic HART® variables can be assigned by the DD or in TROVIS-VIEW
[Settings > Operation unit] as shown in Table 5:

Settings > Operating unit
– Assignment secondary variable: Variable selected according to Table 5 [Valve position]
– Assignment tertiary variable: Variable selected according to Table 5 [Set point deviation e]
– Assignment quaternary variable: Variable selected according to Table 5 [Total valve travel]

The resetting of HART® variables causes all variables to be reset at the same time.

Operation > Reset
– Reset 'HART parameter'

Table 5: *Dynamic HART® variables assignment*

Variable	Meaning	Unit
Reference variable	Reference variable	%
Valve set point	Valve set point	%
Target position	Target position	%
Valve position	Valve position	%
Set point deviation e	Set point deviation e	%
Absolute total valve travel	Absolute total valve travel	–
Binary input status	0 = Not active 1 = Active 255 = –/–	–
Internal solenoid valve/forced venting status	0 = De-energized 1 = Energized 2 = Not installed	–
Condensed state	0 = No message 1 = Maintenance required 2 = Maintenance demanded 3 = Maintenance alarm 4 = Out of specification 7 = Function check	–
Temperature	Temperature	°C

6 Binary input

The following description only applies to positioners fitted with an optional binary input.

The optional binary input can be used to activate various functions:

– [Transfer switching state]
  The switching state of the binary input is logged.
– Set local operation write protection
  After the first initialization, a local write protection can be activated. While the binary input is active, no settings can be changed at the positioner. The positioner cannot be re-initialized. Enabling configuration over Code 3 is not active.
– Start partial stroke test (PST)
  The positioner starts a single partial stroke test. The test is performed with the settings in Code 49 - d2 to Code 49 - d9. See ▶ Section 4.4.
– Go to fail safe reference value
  An on/off valve moves to the predetermined fail-safe set point when the positioner is in automatic mode. This function is not performed if the positioner is in the manual mode or fail-safe position mode.
– Switch between AUTO/MAN
  The positioner changes from the automatic mode to the manual mode or vice versa. This function is not performed if the positioner is in the fail-safe position mode.
– Start data logger
  Activation of the binary input causes the data logger to start. See ▶ Section 3.2.
– Reset diagnosis
  Active functions of statistical information and tests are stopped and the diagnostic data is reset once.
– External solenoid valve connected
  The positioner recognizes and logs that an external solenoid valve is connected.

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

Settings > 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 value, Switch between AUTO/HAND, Start data logger, Reset diagnosis, External solenoid valve connected
– Edge control binary input:
  [On: open switch/Off: closed switch], On: closed switch/Off: open switch
– Fail-safe reference value: 0.0 to 100.0 %, [50.0 %]
– Configuration binary input: [Active], Passive

7 Appendix

7.1 Code list

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
48*	**d0** Current temperature –55.0 to 125.0	Current operating temperature [°C] inside the positioner (accuracy ±3 %) Read only
	d1 Minimum temperature [20]	The lowest temperature [°C] below 20 °C that has ever occurred. Read only
	d2 Maximum temperature [20]	The highest temperature [°C] above 20 °C that has ever occurred. Read only
	d3 Number of zero calibrations	Indicates number of zero calibrations performed since the last initialization Read only
	d4 No. of initializations	The total number of initializations that have been performed since the last reset Read only
	d5 Zero limit 0.0 to 100.0 % of the nominal range, [5.0 %]	Limit for zero monitoring Used for error monitoring of the zero shift.
	d6 Condensed state	Condensed state, made up from the individual states. OK OK C Maintenance required CR Maintenance demanded B Maintenance alarm S Out of specification Read only
	d7 Start reference test [No], YES, ESC	Triggering of a reference test for the functions: Drive signal y steady-state (d1) and drive signal y hysteresis (d2) The reference test can only be activated in manual mode as the valve moves through its entire travel range.

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
	d8 EXPERTplus activation	Firmware version 1.5x and higher without function
48*	**Diagnostic parameters h**	
	h0 Initialization with reference test [No], YES, ESC	Initialization with reference test (the reference graphs for drive signal y steady-state (d1) and drive signal y hysteresis (d2) (Tests) are recorded during the reference test).
	h1 Results of reference test [No], YES	No No reference test has been performed. YES The reference graphs for drive signal y steady-state (d1) and drive signal y hysteresis (d2) (Tests) have been plotted successfully. Read only
	h2 Unassigned	
	h3 Auto reset diAG [0] to 365 days	After an adjustable time period, the diagnosis data are reset automatically according to the settings in Code 36 - diAG. **Example:** A start-up behavior of the plant which is untypical for the process is not to be included in the total diagnosis.
	h4 Remaining time for auto reset diAG	Remaining time until the diagnosis data are reset automatically according to the settings in Code 48 - h3. Read only
49*	**Partial stroke test (PST)/full stroke test (FST) · Application type**	
	A Partial stroke test (PST)	
	A0 Starting the partial stroke test [No], YES, ESC	Operating mode and PST testing mode must be set to MAN.
	A1 Time until next automatic PST	Remaining time [d_h] until the next partial stroke test is performed. Only applies to PST Auto mode. Read only
	A2 Target PST testing mode Auto, [Man], ESC	Activates (PST Auto) or deactivates (PST Man) the scheduled automatic partial stroke test.
	A3 Auto test time	Time [h] between for partial stroke tests (PST)

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
49*	**A4** Status classification of PST status	C Maintenance required OK No message CR Maintenance demanded b Maintenance alarm S Out of specification Read only
	A5 Recommended min. sampling time	Scan time [s] required to plot the complete step response test in a graph. Read only
	A6 Unassigned	
	A7 Δy-monitoring reference value	The valve moves to the valve position Step start (Code 49 - d2) and Step end (Code 49 - d3) with certain control pulses. The difference between these control pulses creates the Δy value [1/s]. The Δy-monitoring reference value applies to the adjusted step values (Code 49 - d2 and Code 49 - d3) and for the selected ramp times (Code 49 - d5 and Code 49 - d6). The Δy-monitoring reference value must be determined again if any of the above mentioned values change. Read only
	A8 Activation Δy-monitoring [No], YES, ESC	Activates or deactivates Δy-monitoring.
	A9 Δy-monitoring value 0 to 100 %, [0 %]	The percentage [%] of the entire range of the control pulse between 1 and 10000 1/s (example: 10 % = 1000 1/s) The partial stroke test is canceled if the change in drive signal (Δy) varies from the Δy-monitoring reference value by this amount.
	d Step parameters for the partial stroke test (PST)	
	d1 Unassigned	
	d2 Step start 0.0 to [100.0]	Start value for step response

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
49*	**d3** Step end 0.0 to 100.0 %, [90.0 %]	Stop value for step response
	d4 Activation of ramp function [No], YES	Activates or deactivates ramp function.
	d5 Ramp time (increasing) 0 to 9999 s, [60 s]	Ramp time for 0 to 100 % travel (increasing) of ramp function Initialization provides a sensible value that is not to be undercut, if possible.
	d6 Ramp time (decreasing) 0 to 9999 s,[600 s]	Ramp time for 100 to 0 % travel (decreasing) of ramp function Initialization provides a sensible value that is not to be undercut, if possible.
	d7 Settling time before starting test [1.0] to 240.0 s	Waiting time before test is started to ensure that value for step start can be reached safely.
	d8 Waiting time after step change 1.0 to 240.0 s [2.0 s]	Waiting time between first step change and start of second step change
	d9 Scan time [0.2] to 250.0 s	Scan time of step response measurement
	E Cancelation conditions of the partial stroke test (PST)	
	E0 Activation x control [No], YES	Activates or deactivates x monitoring.
	E1 x control value –10.0 to 110.0 % of total travel, [0.0 %]	The test is canceled when the valve position – falls below the adjusted value (step end < step start) – exceeds the adjusted value (step end > step start)
	E2 Unassigned	
	E3 Unassigned	

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
49*	**E4** Unassigned	
	E5 Activation PST tolerance band control [No], YES	Activates or deactivates PST tolerance band monitoring.
	E6 PST tolerance band 0.1 to 100.0 %, [5.0 %]	The test is automatically canceled as soon as the Step end (Code 49 - d3) exceeds this percentage.
	E7 Max. test duration, user-defined [30] to 25000 s	Maximum time within which a test can be completed before the test is canceled automatically.
	F Partial stroke test (PST) information · Read only	
	F0 No test available	No test available or test canceled manually.
	F1 Test OK	
	F2 x cancelation	The test was canceled by x cancelation function.
	F3 y cancelation	The test was canceled by y cancelation function.
	F4 Tolerance band exceeded	The test was canceled. The x-values are outside the tolerance band.
	F5 Max. test duration exceeded	The test was not completed within the max. test time and was automatically canceled.
	F6 Test canceled manually	The test has been manually canceled by the user.
	F7 Measured data memory full	Max. memory capacity for measured data reached. After recording 100 measured values per variable, logging is stopped, but the test continues until it is completed.
	F8 Int. solenoid valve	The test was canceled by the activation of the solenoid valve.
	F9 Supply pressure/friction	The test was canceled due to insufficient supply pressure or excessive friction.

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
49*	**h Application type (valve)**	
	h0 Application type [No], YES, ESC	No Control valve YES Open/close (on/off) valve Depending on the adjusted application type, the positioner responds differently in automatic mode and there are differences in the diagnostic functions.
	h1 Operating point 0.0 to [100.0 %] of the valve position	The valve is moved to this valve position as soon as the reference variable exceeds the limit operating point (Code 49 – h5).
	h2 Limit fail-safe position 0.0 to 20.0 % of the reference variable, [12.5 %]	The valve is moved to its fail-safe position (SAFE) when the value falls below this limit.
	h3 Lower limit to start test [25.0 % of reference variable]	The valve remains in its last valid position between the fail-safe position limit and the lower test limit. A partial stroke test is performed after six seconds when the valve is between the upper and lower test limit. Read only
	h4 Upper limit to start test [50.0 % of reference variable]	The valve remains in its last valid position between the upper test limit and the operating point limit. Read only
	h5 Operating point limit 55.0 to 100.0 % of reference variable, [75.0 %]	Valve is moved to the operating point when the operating point limit is exceeded.
	h6 Unassigned	
	h7 Travel time assessment limit [0.6] to 30.0 s	Time limit for difference between reference value and currently recorded value. Determines the difference at which a message is generated.
	h8 Travel assessment limit 0.1 to 100.0 % of the valve position, [0.3 %]	Travel limit for difference between reference value and currently recorded value. Determines the difference at which a message is generated.

Code no.	**Parameter** – Readings/ values [default setting]	Description
Note: Codes with marked with an asterisk (*) must be enabled with Code **3** prior to configuration.		
49*	**h9** Status classification for on/off	C Maintenance required OK No message CR Maintenance demanded b Maintenance alarm S Out of specification Read only

7.2 Error messages and recommended corrective action

Message	Possible reasons	Recommended action	Status classification	Single reset
Diagnosis > Status messages				
Control loop (Code 57)	– Actuator is blocked. – Positioner attachment has shifted subsequently. – Insufficient supply pressure	– Check attachment. – Check supply pressure.	• [◈]	–
Zero point (Code 58)	– Mounting arrangement or linkage has slipped. – Valve trim, particularly with soft seat, is worn.	– Check valve and positioner attachment. – Calibrate zero. – We recommend to re-initialize the positioner if zero deviates by more than 5 %.	• [◈]	•
Autocorrection (Code 59)	Data section error in positioner.	–	–	•
Fatal error (Code 60)	– Error detected in safety-relevant data. Possible cause: EMC disturbances. The valve is moved to fail-safe position.	–	–	–
w too small (Code 63)	The set point (w) is smaller than 3.7 mA.	Check set point (w). If necessary, adjust the current source's lower limit so that no values lower than 3.7 mA can be applied.	• [⊗]	–
Total valve travel exceeded	'Absolute total valve travel' exceeded 'Total valve travel limit'.	–	• [◈]	–
Temperature exceeded	–	–	• [⊗]	–
Extended diagnosis (Code 79)	Extended diagnostics messages generated by EXPERTplus. See Diagnosis > Status messages > Extended.	–	–	

Message	Possible reasons	Recommended action	Status classification	Single reset
Reference variable outside range	Set point smaller than 4 mA or greater than 20 mA.	If possible, limit current source at lower (4 mA) and/or upper (20 mA) limit.	–	–
x-signal (Code 62)	– Actuator's measured value recording failed. – Conductive plastic element defective.	Return positioner to SAMSON for repair.	• []	–
i/p converter (Code 64)	Current circuit of i/p converter interrupted.	Return positioner to SAMSON for repair.	–	–
Hardware (Code 65)	– Hardware error The valve is moved to fail-safe position.	Confirm error and select 'Automatic' operating mode. If not successful, reset initialization and re-initialize the positioner.	• []	•
Data memory (Code 66)	– No more data can be written to the data memory. The valve is moved to fail-safe position.	Confirm error and select 'Automatic' operating mode. If not successful, reset initialization and re-initialize the positioner.	–	–
Control calculation (Code 67)	Hardware error has occurred.	Confirm error. If error cannot be confirmed, return positioner to SAMSON for repair.	• []	•
Program load error (Code 77)	– A program has been loaded that does match the positioner. The valve is moved to fail-safe position.	Interrupt current signal and restart the positioner. If this is not possible, return positioner to SAMSON for repair.	–	–
x > range (Code 50)	– Pin not mounted properly. – NAMUR attachment: bracket slipped or follower pin not properly seated on the follower plate's slot. – Follower plate not mounted properly.	– Check attachment and pin position. – Re-initialize positioner.	• []	•
Delta x < range (Code 51)	– Pin not mounted properly. – Wrong lever mounted. – Pressure limit set too low.	– Check attachment and pressure limit. – Re-initialize positioner.	• []	•

Message	Possible reasons	Recommended action	Status classification	Single reset
Attachment (Code 52)	– Wrong lever mounted. – Supply pressure too low; valve cannot be moved to desired position. – Nominal range could not be reached during nominal range initialization (NOM).	– Check attachment and supply pressure. – Re-initialize positioner.	• [◆]	•
Initialization time exceeded (Code 53)	– Initialization cycle takes too long (> 90 s). The positioner returns to its previous operating mode. – Supply pressure too low. Actuator too slow. – Positioner cannot find fixed travel/angle stops.	– Check supply pressure. – Install a booster. – Adjust travel/angle stops. – Re-initialize positioner.	• [◆]	•
Transit time not reached (Code 55)	Actuator transit times detected during initialization are so short (< 0.3 s) that optimal positioner tuning is impossible.	– Activate volume restriction in positioner output. – Re-initialize positioner.	• [◆]	•
Pin position/fail-safe switch (Code 56)	Pin position not entered for nominal range (NOM) or substitute (SUB) initialization.	– Enter pin position and nominal range. – Re-initialize positioner.	• [◆]	•
	ATO/ATC switch defective.	Return positioner to SAMSON for repair.		
No emergency mode (Code 76)	Positioner detected during initialization that actuator permits no emergency control mode without feedback. In case of a travel sensing error, positioner vents Output or A1 in double-acting actuators.	For your information only. No further action required.	• [⊗]	–
Reference test aborted (Code 81)	Error while the reference graph 'Drive signal diagram steady-state (d1)' or 'Drive signal diagram hysteresis (d2)' is automatically plotted during initialization	Check and perform new reference test, if necessary.	• [◆]	–
Control parameters (Code 68)	Error in control parameters.	Confirm error. If not successful, reset initialization and re-initialize the positioner.	• [◆]	•

Message	Possible reasons	Recommended action	Status classification	Single reset
Potentiometer parameter (Code 69)	Error in digital potentiometer parameter.	Confirm error. If not successful, reset initialization and re-initialize the positioner.	• [◈]	•
Adjustment (calibration) parameter (Code 70)	Error in data from production calibration.	Return positioner to SAMSON for repair.	• [◈]	–
General parameters (Code 71)	Error in parameters not critical to control operation.	Confirm error.	• [◈]	•
Internal device error 1 (Code 73)	Internal device error	Return positioner to SAMSON for repair.	• [◈]	–
HART parameter (Code 74)	Error in HART® parameters not critical to control operation.	Confirm error and change parameter, if necessary.	• [◈]	•
Options parameter (Code 78)	Error in option parameters.	Return positioner to SAMSON for repair.	• [◈]	–
Diagnosis parameter (Code 80)	Error in parameters not critical to control operation.	Confirm error. Perform new reference test, if necessary.	• [◈]	•
Diagnosis > Status messages > Extended				
Air supply	– The supply pressure has changed. – The supply pressure is insufficient. – The supply pressure is working at full capacity.	Check supply pressure.	• [⊗]	• ▶ Sec. 3.6.2 ▶ Sec. 4.1.2
Shifting working range	The working range has shifted towards CLOSED or max. OPEN position.	Rethink the working range.	• [⊗]	• ▶ Sec. 3.3.2
Leakage pneumatics	A leak in the pneumatics exists.	Check that pneumatic installations and connections are tight.	• [⊗]	• ▶ Sec. 3.6.2 ▶ Sec. 4.1.2
Limit working range	– The working range is limited at upper or lower range value. – The valve has seized up (no change possible).	– Check that pneumatic installations and connections are tight. – Check supply pressure. – Check plug stem for external influences that could be blocking it.	• [⊗]	• ▶ Sec. 3.4.2

Message	Possible reasons	Recommended action	Status classification	Single reset
Observing end position	– Course of end position monotonically increasing/ decreasing. – Course of end position alternates.	Check seat and plug.	• [⊗]	• ▶ Sec. 3.8.2
Positioner-valve linkage	– No optimal travel transmission. – The mechanical link is loose. – The working range is limited.	Check attachment.	• [⊗]	• ▶ Sec. 3.4.2
Working range	– The working range is mainly close to the CLOSED/max. OPEN position. – The working range is mainly in the CLOSED/ max. OPEN position.	Rethink the working range.	• [⊗]	• ▶ Sec. 3.3.2
Friction	– The friction is much higher/lower over the entire working range. – The friction is much higher/lower over a section.	Check the valve's packing.	• [⊗]	• ▶ Sec. 3.7.2 ▶ Sec. 4.2.2
Actuator springs	– The spring stiffness is reduced (spring failure). – The spring pre-loading is reduced. – The actuator springs are working at full capacity.	Check actuator springs.	• [⊗]	• ▶ Sec. 3.6.2 ▶ Sec. 4.1.2
Inner (seat) leakage	Seat leakage exists.	Check seat and plug.	• [⊗]	• ▶ Sec. 3.4.2
External leakage	External leakage may possibly exist or is to be expected soon.	Check the valve's packing.	• [⊗]	• ▶ Sec. 3.5.2
	External leakage is perhaps soon expected.			• ▶ Sec. 3.7.2
PST/FST	The partial stroke test or the full stroke test has not been completed successfully.	Check test cancelation conditions. See section 4.4 and section 4.5.	• [⊗]	• ▶ Sec. 4.4.4 ▶ Sec. 3.5.2

Message	Possible reasons	Recommended action	Status classification	Single reset
Open/Close (on/off)	– The breakaway time or transit time differs from the reference value by the amount entered in 'Limit value time analysis'. – The valve end position differs from the reference value by the amount entered in 'Limit value travel analysis'. – The end position cannot be reached.	– Check that pneumatic installations and connections are tight. – Check supply pressure. – Check plug stem for external influences that could be blocking it.	• [⊗]	• ▶ Sec. 3.1.3

7.3 Diagnostic parameters and measured data saved in a non-volatile memory

Data saved in a non-volatile memory:	Saved directly after they change	Saved cyclically every 24 h
Statistical information		
Open/Close (on/off)	'Limit value time analysis', 'Limit value travel analysis'. Reference assessment	Assessment
Data logger	'Selection', 'Trigger status', 'Scan rate', 'Trigger value', 'Trigger band', 'Trigger edge', 'Pre-trigger time', 'Trigger via condensed state'	
Travel histogram x		Measured values
Short-term monitoring	Scan rate, short-term histogram	
Set point deviation histogram e		Measured values
Short-term monitoring	Scan rate, short-term histogram	
Cycle counter histogram		Measured values
Short-term monitoring		
Drive signal diagram steady-state		Measured values
Short-term monitoring		Measured values
Drive signal diagram hysteresis (d5)	'Start test', 'Enable time distance', 'Min. time distance from test', 'Tolerance band of hysteresis'	Measured values
Short-term monitoring		
Lower end position	Measured data	
Tests		
Drive signal diagram steady-state (d1)	Values of the reference test 'Reference time stamp'	
Drive signal diagram hysteresis (d2)	Values of the reference test Reference time stamp	
Static characteristic (d3)		

Data saved in a non-volatile memory:	Saved directly after they change	Saved cyclically every 24 h
Partial stroke test (d4)	'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', 'Delay time after step', 'Scan rate', 'Max. test duration', 'Number of step responses', 'Activation x control', 'x control value', 'Activation delta y-monitoring', 'delta y-monitoring value', 'Activation PST tolerance band control', 'PST tolerance band' delta y-monitoring reference value, course of step response, analysis of measured data, number of tests	
Full stroke test (d6)	'Tolerance limit of step response', 'Activation of the ramp function', 'Ramp time (rising)', 'Ramp time (falling)', 'Settling time before test start', 'Delay time after step', 'Scan rate', 'Max. test duration', 'Number of step responses', 'Max. breakaway time', "Activation 'Max. breakaway time'", 'Allowed time to reach full closed position', "Activation 'Allowed time to reach full closed position'" Course of step response, analysis of measured data, number of tests	
General		
Actuator and valve data specifications	Yes	
Logging	Yes	
Classification of status messages	Yes	

7.4 Determining the ramp times of the partial stroke test

Suitable ramp times for the partial stroke test can be determined by performing a full stroke test.

NOTICE

See section 4.5 on how to perform a full stroke test.

1. Adjust the FST diagnostic parameters as follows:
   'Tolerance limit of step response' = 2.0 % (WE)
   'Activation of the ramp function' = Yes (WE)
   'Ramp time (rising)' = 900 s
   'Ramp time (falling)' = 900 s
   'Settling time before test start' = 10 s
   'Delay time after step' = 4.0 s
   'Scan rate' = 'Min. recommended scan rate'
2. Adjust 'Scan time' of the data logger to 0.2 s and start the data logger ('Selection' = Permanent). See section 3.2.
3. Start full stroke test and change directly to the data logger graph.
4. After the full stroke test is finished, stop the data logger and save the data.
5. Analyze the logged data: If the valve position follows the set point closely, the adjusted ramp times can be used for the partial stroke test. If this is not the case, repeat the full stroke test with different ramp times until the valve position follows the set point (Fig. 16).

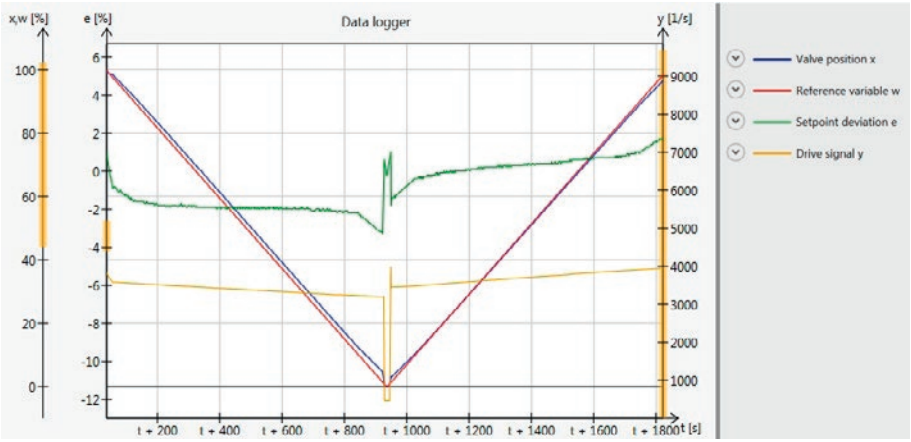


Fig. 16: *Full stroke test to determine the ramp times for the partial stroke test*
The valve position closely follows the set point in the example shown here

Abbreviations used

e	Set point deviation
p_{out}	Signal pressure
ps	Supply pressure
x	Valve position
x_0	Valve position when the valve is tightly shut
w	Set point, reference variable
BE	Binary input
FV	Forced venting
SV	Solenoid valve
ZP	Zero point

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