DATA SHEET

T 8389-3 EN

EXPERTplus Valve Diagnostics

TROVIS 3730-3 Electropneumatic Positioner

Application

Positioner firmware to detect potential valve faults and to provide maintenance recommendations

The EXPERTplus valve diagnostics can detect faults and provide predictive, status-oriented maintenance recommendations for valves with pneumatic actuators. The full scope of diagnostic functions is completely integrated into the positioner. The numerous diagnostic functions allow faults to be pinpointed in control valves at an early stage.

The TROVIS-VIEW software, which allows the user to access, read and edit the diagnosis, is easy to learn. The integration options including eDD, eEDD, FDT/DTM allow the diagnostic functions to be also used in other engineering tools. Classified status messages and the condensed state conforming to the NAMUR Recommendation NE 107 can also be read on site at the positioner display.

TROVIS-VIEW: User interface used to configure various SAMSON devices

FDT: Field device tool for the manufacturer-independent integration of field devices

DTM: Device type manager to describe the device and communication properties

DD/eDD: Device description/enhanced device description

Fig. 1: *TROVIS 3730-3 Positioner with EXPERTplus valve diagnostics*

Special features

- Diagnosis data are constantly compiled, saved and analyzed in the positioner. Status messages are automatically generated. Test data and their analysis are saved in the positioner.
- Cyclical polling of diagnosis data, multiplexer-capable
- Minimum and maximum temperature readings with an alarm when the limits have been exceeded
- Statistical information (in-service monitoring) and tests (out-of-service diagnostics) pinpoint critical states before malfunctions can affect the process, allowing the user to plan predictive maintenance and service work on control valves
- Display of classified status and error messages
- Status classification and condensed state based on NAMUR Recommendation NE 107
- Status messages and condensed state can also be read off at the positioner display
- Operating hours counter allows data and events to be sorted by time
- Step response test to assess the valve's ability to move
- Diagnosis data, test results and analysis saved in the positioner

Options

- Binary input, e.g. to start tests, monitor external solenoid valve etc.

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Table 1: *Overview of EXPERTplus functions*

Function	See section	Description	From user level [1]
Start-up diagnostics	1.1	Positioner self-test, mechanical attachment, valve working range, initialization time, opening and closing times	On-site: read
Current process variables	1.2.1	Process variables: set point, valve position, set point deviation, operating hours counter	On-site: read
Operating parameters	1.2.2	Number of zero calibrations and initializations, temperature, total valve travel, self-monitoring of positioner	On-site: read
Status messages/ classification	1.2.3	Display and logging of classified status messages and condensed state	Diagnostics
	3.1	Status classification change	Diagnostics
Statistical information Data are compiled, saved and analyzed by the positioner while the process is running without disrupting the process. The data are saved and analyzed in the positioner, i.e. the positioner follows the set point to position the valve. A classified status message or error message is generated if the positioner detects an event.			
Valve position histogram	2.1.1	Statistical distribution of the valve position	Diagnostics
Set point deviation histogram	2.1.1	Statistical distribution of the set point deviation	Diagnostics
Load cycle histogram	2.1.1	Statistical distribution of the load cycle, dynamic stress factor acting on packing and metal bellows	Diagnostics
Course of end position	2.1.2	Observing end position, detection of zero shift	Diagnostics
Tests Similar to the statistical information, data are compiled, saved and analyzed by the positioner. However, in this case, the valve position is not determined by the set point, but the active test. The tests can only be started when the conditions in the plant allow it (e.g. plant shutdown or service work in the workshop).			
Step response test (SRT)	2.2.1	Time stamp, dead time, T86, overshooting, test status	On-site: write [2], diagnostics
Step response test (SRT-100 %)	2.2.2	Time stamp, dead time (rising/falling), T86 (rising/falling), T98 (rising/falling), test status	On-site: write [2], diagnostics
Dead band	2.2.3	Minimum dead band, maximum dead band, average dead band	Diagnostics
Status messages			
Software for visualization and parameterization	3	Collected data and analysis results can be displayed in graphs.	On-site: read
Options			
Binary input	4	Positioner with binary input option: logged actions of single functions and tests	Diagnostics

[1] The positioner has three user levels with various read and write access privileges:
- On-site: read · Parameters, which can be displayed at the positioner, can be read using the software
- On-site: write · Parameters, which can be displayed at the positioner, can be read and written using the software
- Diagnosis · Parameters, which can be displayed at the positioner as well as the diagnostic parameters, can be read and written using the software

[2] Restricted function (including test start and test stop)

1 EXPERTplus valve diagnostics

1.1 Start-up diagnostics

EXPERTplus monitors the valve during automatic initialization to ensure trouble-free start-up. At the same time, the supply and venting times are determined.

The diagnosis also highlights any faults concerning attachment and the valve working range as well as any hardware, data memory and initialization time errors.

1.2 Process variables and operating parameters

1.2.1 Current process variables

EXPERTplus provides the key process variables collected by the positioner (set point, controlled variable, set point deviation and temperature) and analyzes the diagnostic data.

1.2.2 Key operating parameters/status messages

To evaluate the current condition of the valve and schedule maintenance routines, EXPERTplus provides the user with a summary on the device state. The status messages for the operating parameters listed below are time-stamped:

- Operating hours counter, distinction between positioner switched on since last initialization, positioner in closed-loop operation and positioner in closed-loop operation since last initialization
- Number of zero calibrations
- Number of initializations performed
- Setting a status message
- Resetting a status message
- Completion of a test

1.2.3 Pinpointing faults and their sources

The alarm and status messages generated by EXPERTplus allow faults to be pinpointed quickly. The last 400 generated messages are saved in a FIFO memory with a time-stamp (logged by the operating hours counter). Faults can be pinpointed quickly as a result.

The status messages are divided into the following categories:

- Start-up
- Configuration
- Process data
- Control valve diagnosis
- AMR signal outside range
- Limit for total valve travel exceeded
- Lower/upper end position shifted
- Dynamic stress factor exceeded
- Set point deviation
- Brownout
- Current too low/too high
- IP shutdown
- Temperature inside device below min. limit/above max. limit
- Angle limitation
- Logging suspended
- Operating range in CLOSED position/max. OPEN position
- Operating range shifts towards CLOSED position/max. OPEN position
- Limited working range: lower/upper range

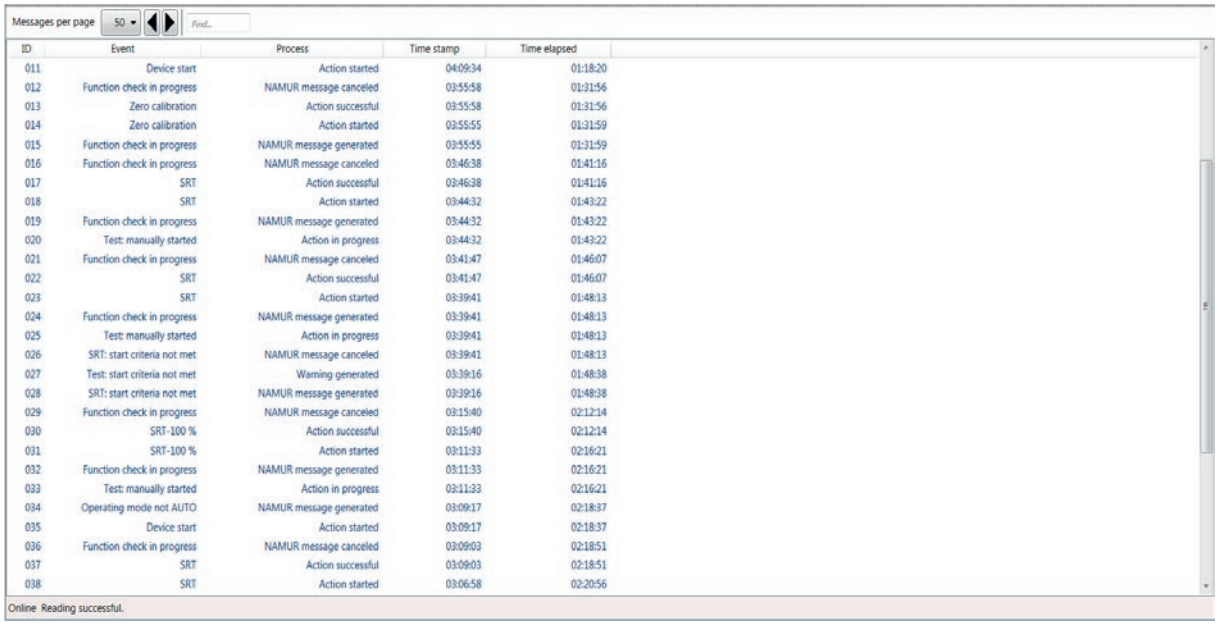

Fig. 2: *Event logging*

2 Functions

2.1 Statistical information

By permanently recording raw diagnostic data in the positioner, the user can gather information about how the valve behaves under process conditions.

The continuous recording of signals enables an analysis of the current measurement span as well as of the positioner's entire service life.

Recommendations for predictive maintenance can be given based on the statistical information. In addition, immediately required action is reported.

2.1.1 Histograms

Data are recorded in the background regardless of the operating mode selected. The data are plotted over the service life or over a user-defined monitoring period in a histogram.

Valve position

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

Set point deviation

The set point deviation histogram contains a statistical analysis of any set point deviations recorded. This provides a summary of how often and to which level a set point deviation has occurred during the valve service life and whether it shows a recent trend concerning the set point deviation. Ideally, the set point deviation should be as small as possible.

Load cycle

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

The positioner generates a corresponding message when the histogram analysis indicates that the dynamic stress factor is outside the permitted range.

2.1.2 Course of end position

The positioner monitors the lower and upper end positions to detect wear and dirt in the trim at an early stage. The valve position is recorded when the lower end position is reached and any changes logged with a time stamp. The first measured value is used as a reference.

Shifts in the end position are registered according to the assigned status classification.

2.2 Tests

Before performing the tests, it is important to make sure whether the conditions (in the plant or process) allow the valve to be moved.

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

2.2.1 Step response test (SRT)

The step response test (SRT) is particularly suitable for the status-oriented detection of malfunctions in pneumatic shut-off valves. As a result, the probability of failure on demand (PFD) can be reduced and it may be possible to extend maintenance intervals. A shut-off valve normally in its end position can be prevented from seizing up or getting jammed. The initial breakaway torque must first be overcome after the valve starts to move from its end position. The initial breakaway torque depends on the plug/seat seal, deposits on the plug, the process medium and friction at the valve trim. After the initial breakaway torque has been overcome, it can be assumed that the valve is able to close completely. The recording of the test results additionally allows an analysis of the dynamic control response. During the test, the valve is moved through a user-defined working range.

A report and diagram show the test results. The positioner can save a maximum of 52 reports and 7 diagrams.

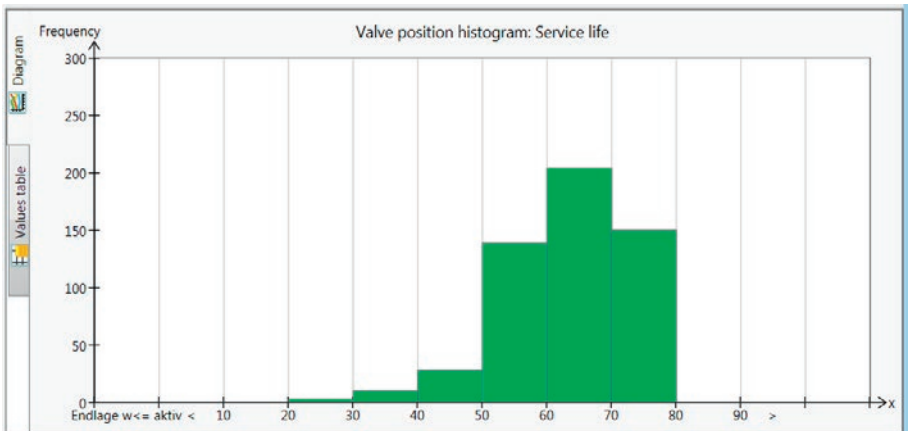

Fig. 3: *Valve position histogram*

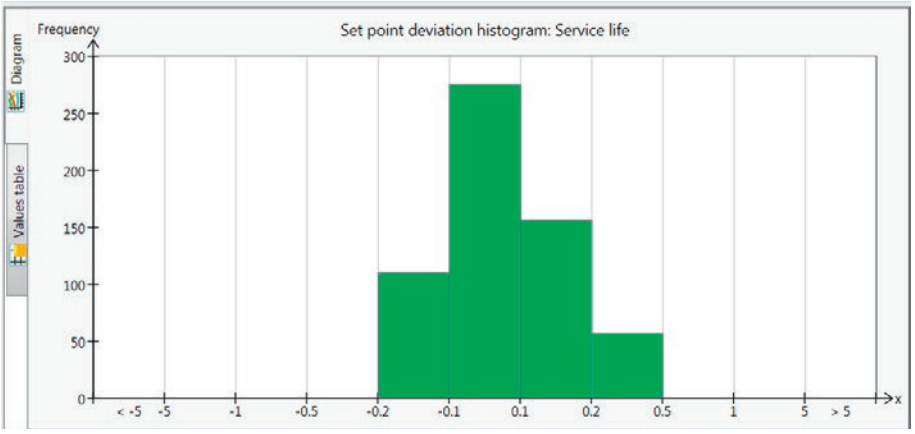

Fig. 4: *Set point deviation histogram*

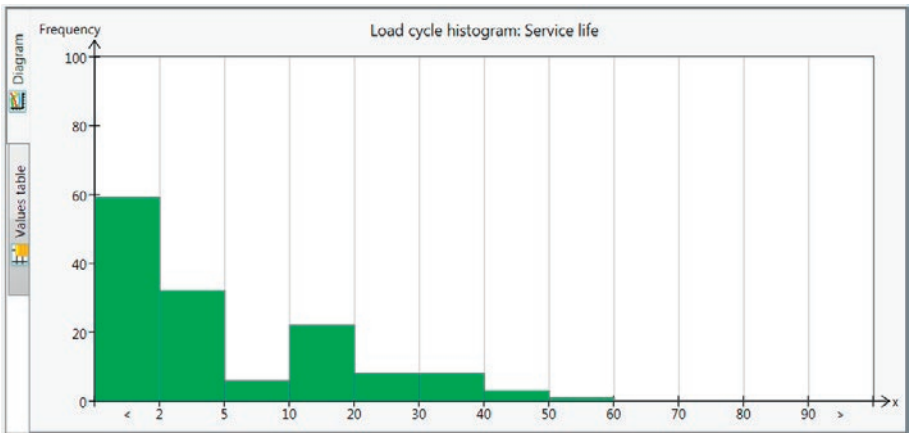

Fig. 5: *Load cycle histogram*

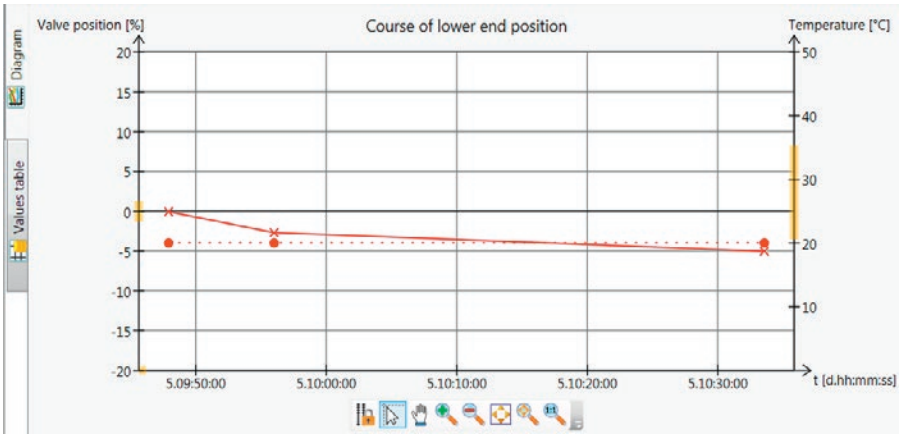

Fig. 6: *Course of lower end position*

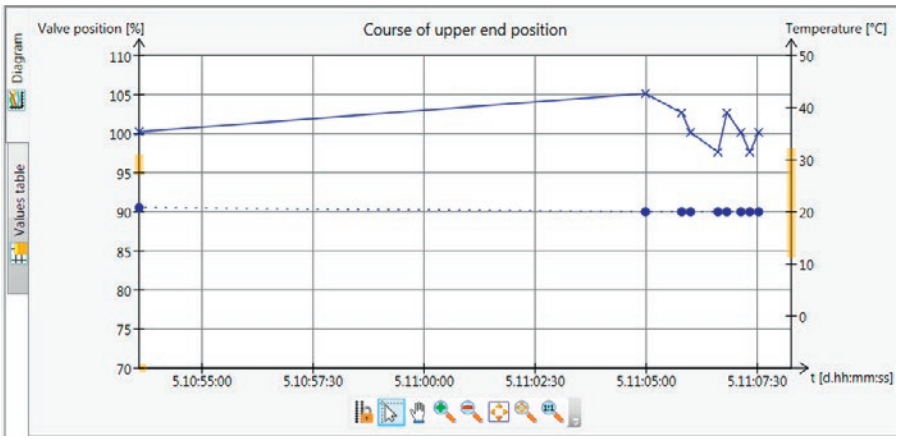

Fig. 7: *Course of upper end position*

2.2.2 Step response test (SRT-100 %)

The dynamic valve performance can be evaluated by performing the test. During the step response test (SRT-100 %), the valve moves through its entire working range, contrary to the step response test (SRT).

A report and diagram show the test results. The positioner can save a maximum of 7 reports and 7 diagrams.

2.2.3 Dead band

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

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

A plotted diagram is generated after the test is successfully completed.

3 Visualization and parameterization of the integrated EXPERTplus diagnostics

The TROVIS-VIEW software or the DTM tool generate graphs from the data, test results and status messages collected by the diagnostic firmware in the positioner.

In addition, the diagnostic data can also be made accessible to other engineering tools using the DD (device description). The eDD (enhanced device description) enables the data to be displayed in a graph, e.g. using Siemens PDM, AMS. How the data are displayed depends on the tool.

3.1 Classification and marking of status messages

Based on NAMUR recommendation NE 107, the messages (events) generated by EXPERTplus are assigned a status (classified).

The status messages can be classified as required. The classified status messages (event) are summarized in a condensed state:

Condensed state

Status message	TROVIS-VIEW/ DTM
No message, OK	green
Maintenance required	blue
Out of specification	yellow
Function check	orange
Failure	red

The condensed state is indicated on the positioner display and can be read over the communication.

3.2 Graphs in TROVIS-VIEW, DTM, eDD (e.g. Siemens PDM)

The trend-viewer function in TROVIS-VIEW allows the compiled raw data and test results as well as variables recorded in the positioner to be displayed in a graph.

The raw data and test results include:

- Current process variables
- Course of end position
- Step response test (SRT)

The histograms described in section 2.1.1 are displayed as bar graphs.

These graphs make any changes in positioning or control performance apparent to the user and support predictive maintenance.

4 Binary input

The optional binary input allows various actions to be performed which also affect the diagnostic functions. The actions are logged by the positioner.

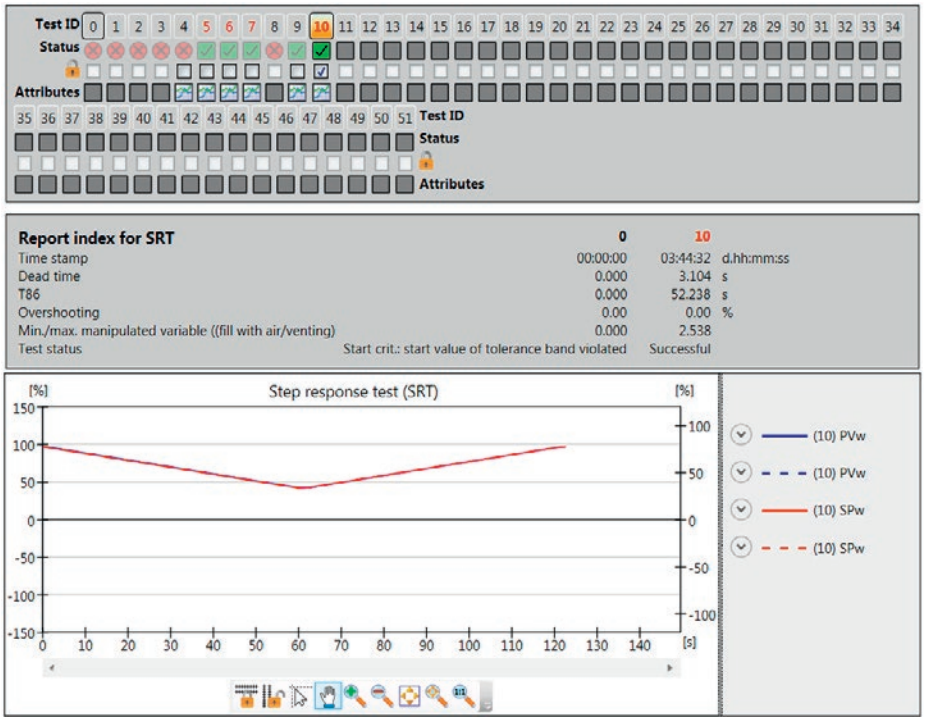

Fig. 8: *Step response test (SRT)*

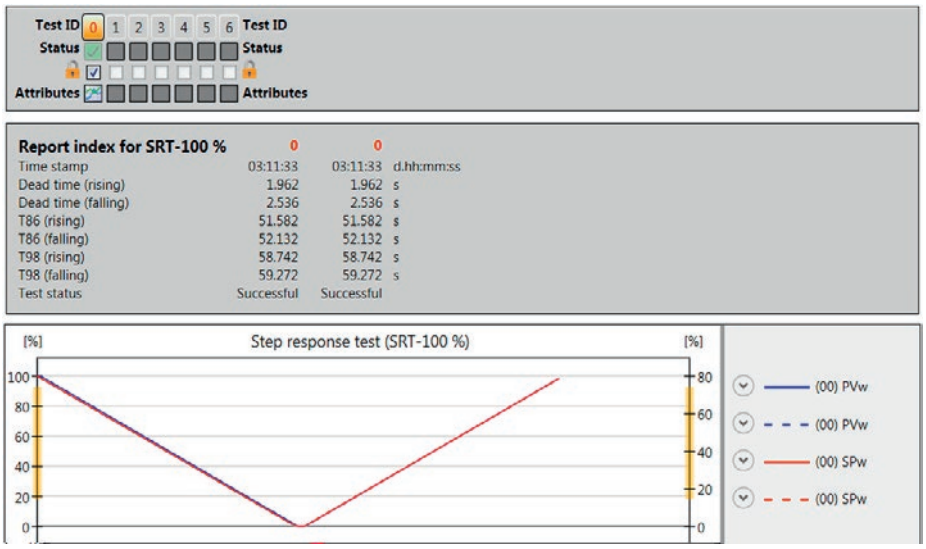

Fig. 9: *Step response test (SRT-100 %)*

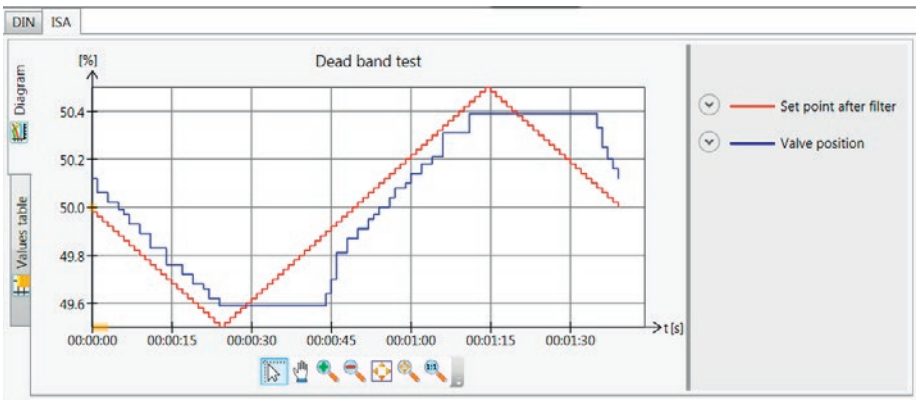

Fig. 10: *Dead band*

Data Sheet for TROVIS-VIEW ▶ **T 6661**
Data Sheet for TROVIS 3730-3 Positioner ▶ **T 8484-3**