# DATA SHEET

**T 8389 EN**

## Series 3730 and 3731 · Types 3730-2, 3730-3, 3730-4, 3730-5 and Type 3731-3 Electropneumatic Positioners

EXPERTplus Valve Diagnostics

**Application**

Positioner firmware to detect potential valve faults and with maintenance recommendations. Valid for firmware version V1.51 and higher

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 and can be issued over the fault alarm contact*.

**TROVIS-VIEW:** Operator 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

**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
- 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
- Minimum and maximum temperature readings with details on how long the limits have been exceeded
- Automatic start of diagnostic functions
- Display of service and maintenance recommendations

Type 3241-1 Control Valve with Type 3730-3 Positioner with HART® communication

Flameproof Type 3731-3 Electropneumatic Positioner

**Fig. 1:** *Positioner with EXPERTplus valve diagnostics*

- Display of classified status and fault 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 or can be issued over the fault alarm contact*
- Plotting of valve signature to detect faults
- Diagnostic function to pinpoint changes in friction
- Operating hours counter allows data and events to be sorted by time
- Diagnosis data, test results and analysis saved in the positioner

**Options**

- Leakage sensor to monitor leakage between valve seat and plug
- Binary input, e.g. to start tests, monitor external solenoid valve, etc.

**Summary of diagnostic functions**

There are two main groups of diagnostic functions available:

**Statistical information**

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.

**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).

Table 1 shows the diagnostic functions with their test analyses.

# 1 EXPERTplus valve diagnostics

## 1.1 Start-up diagnostics

EXPERTplus monitors the valve during automatic initialization to ensure trouble-free start-up. During which, the opening and closing times are determined.

The diagnosis also indicates faults concerning attachment and the entire valve working range as well as hardware, data memory defects and the initialization time.

## 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 w, valve position x, drive signal y, set point deviation e and temperature t) 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 status summary. The status messages for the operating parameters listed below are time-stamped:

- Operating hours counter, distinction between positioner switched on and positioner in closed-loop operation (since the first start-up and the last initialization routine)
- Number of zero calibrations performed
- Number of initializations performed
- Display of the current temperature as well as saving of the maximum and minimum temperatures, including alarm function when a limit is exceeded
- Total valve travel, including programmable limit

**Table 1:** *Overview of EXPERTplus functions*

| Function | See section | Description |
|---|---|---|
| Start-up diagnostics | 1.1 | Positioner self-test, mechanical attachment, valve working range, initialization time, opening and closing times |
| Current process variables | 1.2.1 | Process variables: set point w, valve position x, drive signal y, set point deviation e, operating hours counter |
| Operating parameters | 1.2.2 | Number of zero calibrations and initializations, temperature, total valve travel, self-monitoring of positioner |
| Status messages Classification | 1.2.3<br>3.1 | Display and logging of classified status messages and condensed state |
| **Statistical information** | | |
| Data logger | 2.1.1 | Recording and saving of set point w, valve position x, drive signal y, set point deviation e with triggering function |
| Valve position x histogram | 2.1.2 | Shifting working range, working range |
| Set point deviation histogram | 2.1.3 | Limiting the working range, inner leakage, connection positioner-valve, absolute value of max. set point deviation |
| Cycle counter histogram | 2.1.4 | External leakage, dynamic stress factor acting on packing and metal bellows |
| Drive signal diagram steady-state | 2.1.5 | Supply pressure, leakage in pneumatics |
| Drive signal diagram hysteresis | 2.1.6 | Friction, external leakage |
| Trend of travel end position | 2.1.7 | Observing end position, zero shift |
| **Tests** | | |
| Drive signal diagram steady-state | 2.2.1 | Supply pressure, leakage in pneumatics, actuator springs |
| Drive signal diagram hysteresis | 2.2.2 | Friction, external leakage |
| Static characteristic | 2.2.3 | Dead band of the valve |
| **Status messages** | | |
| Software for visualization and parameterization | 3 | Collected data and analysis results can be displayed in graphs. |
| **Options** | | |
| Binary input | 4 | Logged actions of single functions and tests |

### 1.2.3 Pinpointing faults and their sources

The alarm and status messages generated by EXPERTplus allow faults to be pinpointed quickly. The last 30 generated messages are saved in a FIFO memory with a time-stamp (logged by the operating hours counter).

The status messages are divided into the following categories:

- Status messages
- Operational messages
- Hardware messages
- Initialization messages
- Data memory messages
- Temperature messages
- Extended status messages
- Operational error e.g.:
  - Control loop error (excessive error, e.g. blocked actuator, insufficient supply pressure etc.)
  - Zero shift
  - Hardware
  - Data memory
  - Temperature
  - Initialization

# 2 Functions

## 2.1 Statistical information

By permanently recording raw diagnostic data (w, x, y and e) in the positioner, the user can gather information about how the valve behaves under process conditions.

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

The following statements can be made, for example:

- Valve positioning range OK
- Valve mainly operates in the upper or the lower end position
- Dynamic stress factor

As a result, recommendations for predictive maintenance can be given. In addition, immediately required action is reported.

### 2.1.1 Data logger

Process variables (e.g. set point w, valve position x, drive signal y, set point deviation e, operating hours counter) are logged. The last 100 data points per variable are saved in a FIFO memory in the positioner. The time between logging data points is user-definable.

Apart from permanent sampling, the data can also be collected online while the process is running, provided a certain trigger condition is met. The trigger condition can be defined by the user as certain thresholds.

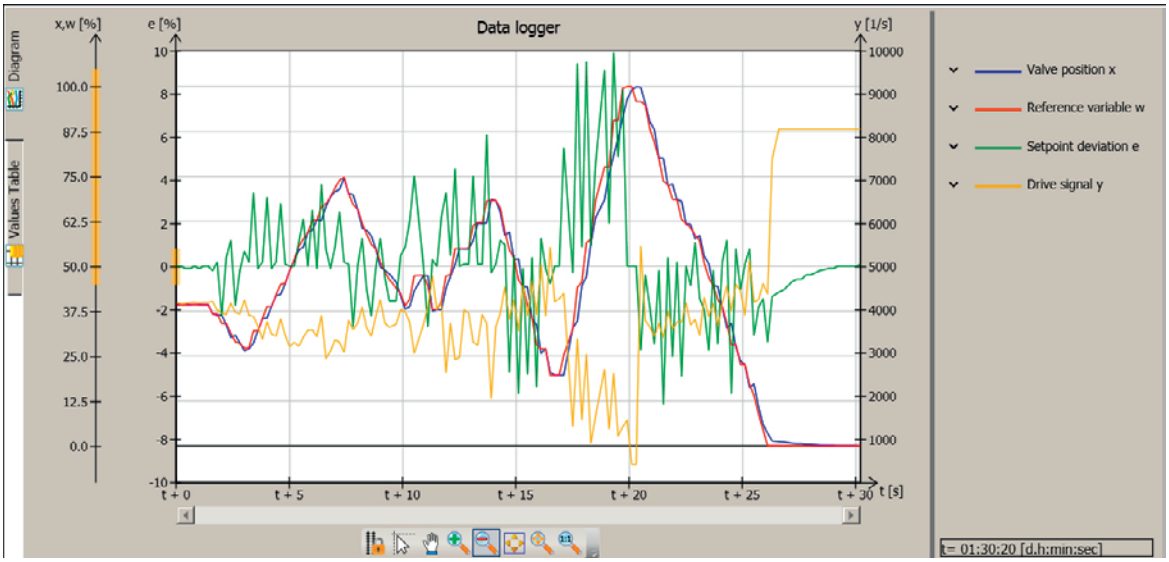


**Fig. 2:** *Data logger*

### 2.1.2 Valve position histogram

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

Data are recorded in the background regardless of the operating mode selected. A short-term histogram and a long-term histogram are plotted.

The positioner generates a status message if the analysis of the travel histogram detects a shifting working range or working range error.

### 2.1.3 Set point deviation histogram

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.

Data are recorded in the background regardless of the operating mode selected. A short-term histogram and a long-term histogram are plotted.

The positioner generates a status message if the histogram detects a limit working range, inner leakage or connection positioner/valve error.

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

Data are recorded in the background regardless of the operating mode selected. A short-term histogram and a long-term histogram are plotted.

If the analysis detects an error, the positioner generates a corresponding status message.

### 2.1.5 Drive signal diagram steady-state

Steady-state drive signal diagram allows changes in the supply pressure or leakage in the pneumatics to be detected. If the supply pressure is insufficient for the actuator to move through the entire bench range, this pinpoints a fault in supply pressure or leakage in the pneumatics.

Data are recorded and analyzed in the background regardless of the operating mode selected (provided a reference graph has been made). A short-term monitoring listing the measured data and a long-term monitoring in a graph are possible.

If the analysis detects an error, the positioner generates a corresponding status message.

### 2.1.6 Drive signal diagram hysteresis

The hysteresis test allows changes in friction to be analyzed. The positioner generates a status message when the results of the hysteresis test pinpoint to friction or external leakage.

If a reference graph exists, the hysteresis test can be started in both AUTO or MAN operating modes. The test can be performed once or cyclically.

A short-term monitoring listing measured data and a long-term monitoring in a graph provide an analysis of the measured data.

If the analysis detects an error, the positioner generates a corresponding status message.

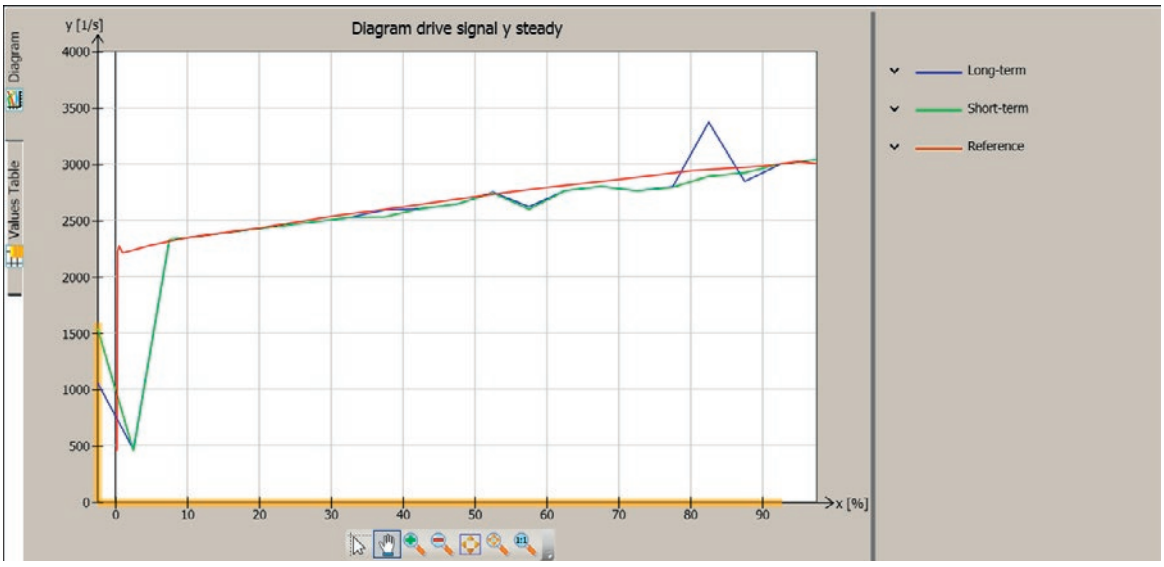


**Fig. 3:** *Drive signal diagram steady-state*

### 2.1.7 Trend of travel end position

This test serves to detect wear or dirt on the valve trim and is run automatically while the process is running. The valve position is recorded when the lower end position is reached and any changes logged together with the drive signal y and a time stamp. The first measured value is used as a reference.

Shifts in the end position are registered.

## 2.2 Tests

For reasons of safety, the tests (out-of-service diagnostics) can only be started when the positioner is in the MAN operating mode. Therefore, it is important to make sure before starting a test 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 Drive signal diagram steady-state

The drive signal diagram steady-state allows the results of the steady-state drive signal diagram in Statistical information (in-service monitoring) to be checked more closely.

After starting the test in the MAN mode, the valve moves to various fixed valve positions. The drive signal y is measured for each valve position x and compared with the reference graph. The statements on the following faults can be made:

- Supply pressure
- Pneumatic leakage or
- Actuator springs

If the analysis detects an error, the positioner generates a corresponding status message.

### 2.2.2 Drive signal diagram hysteresis

The drive signal diagram hysteresis allows the results of the steady-state drive signal diagram in Statistical information (in-service monitoring) to be checked more closely. The hysteresis test allows changes in friction to be analyzed.

The test is started in the MAN mode. The valve moves to various fixed valve positions. After moving to the valve position, a ramp movement changing the valve travel is performed. The change in drive signal Δy is measured compared with the reference data.

The positioner generates a corresponding status message if the analysis of the drive signal pinpoints friction or external leakage.

### 2.2.3 Static characteristic

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

The test is started in the MAN mode. The positioner determines the set point w in a defined test range in small steps and records the response of the valve position x after waiting a predetermined time.

An analysis of the control loop is possible from the recording and detection of min. dead band, max. dead band and average dead band.

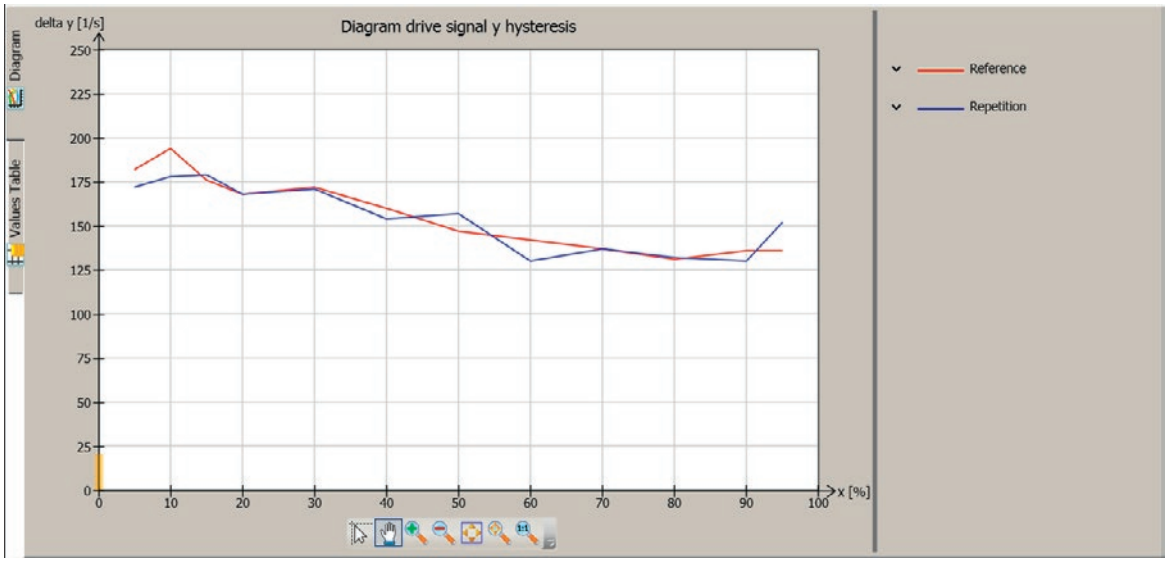


**Fig. 4:** *Drive signal diagram hysteresis*

# 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 | Positioner |
|---|---|---|
| No message, OK | green | |
| Function check | orange | Text e.g. tESting, tunE, tESt |
| Maintenance required, maintenance demanded | blue | |
| Out of specification | yellow | blinking |
| Maintenance alarm | red | |

The condensed state is indicated on the positioner display and can be read over the communication. Additionally, the condensed state is also issued at the fault alarm output*.

## 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 (w, x, e, y) recorded in the data logger to be displayed in a graph.

The raw data and test results include:

- Current process variables
- Valve signature
- Hysteresis measurement
- Static characteristic
- Step response
- Trend of travel end position

The long-term and short-term histograms described in sections 2.1.2 to 2.1.4 are displayed as bar graphs.

The long-term and short-term valve signature and histograms are available.

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 of Types 3730-2/-3 and Type 3731-3 allows various actions to be performed which also affect the diagnostic functions. The actions are logged by the positioner.

* Fault alarm contact in Types 3730-2 and 3730-3, as option in Type 3731-3