

Intelligent valve controller

Neles™ ND9000P

User's guide
Rev. 1.04

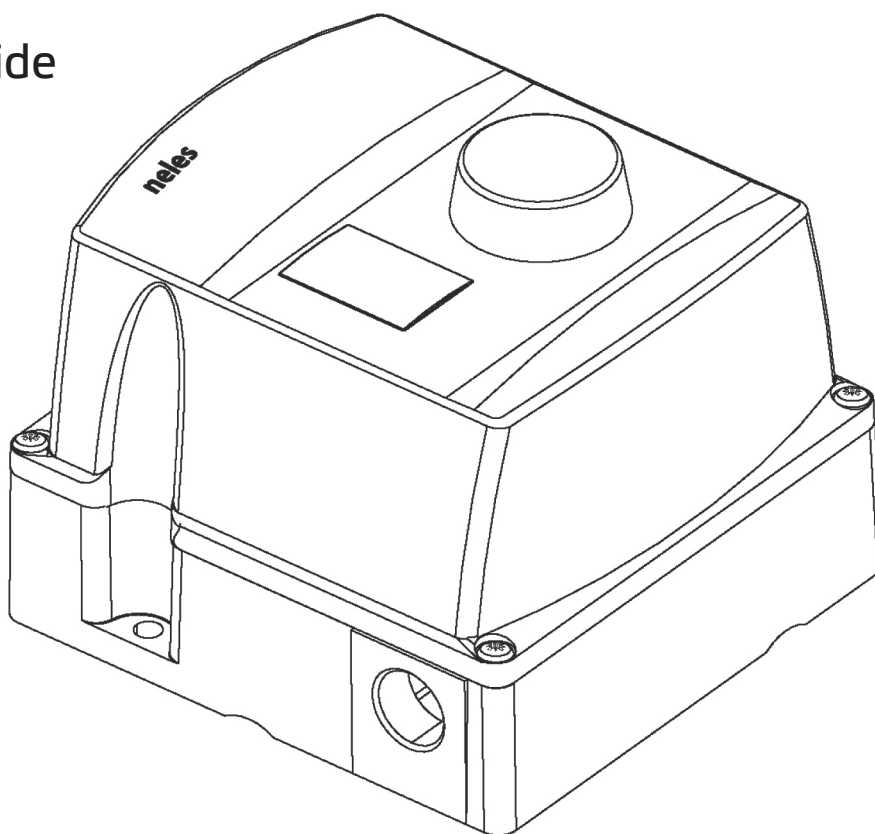


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1 Introduction

Neles ND9000P is a top-class intelligent valve controller that is designed to operate on all valve packages in all industry areas. Its superior design features and unique diagnostics provide a solid foundation for performance optimisation and proactive maintenance. It guarantees a high-quality end product in all operating conditions.

Simatic PDM is a field device configurator software (by Siemens) that supports PROFIBUS DP/PA and HART devices.

This manual describes the ND9000P configuration and diagnostics using the Simatic PDM.

2 Device setup

2.1 GSD file installation

The GSD file is needed for the PROFIBUS master (class 1) to be able to configure the cyclic DP communication between the master and the slave. The Profibus master could be a DCS or PLC from any vendor. All of these systems have their own, vendor specific configuration tools. All of these tools understand the ND9000P GSD file.

Each control system has a GSD library. If the library does not already contain the ND9000P GSD file, it can be downloaded from www.profibus.com or www.valmet.com. The ND9000P GSD file name is **Nel_06CA.gsd**.

Each control system has different tools to import the GSD file to the GSD library. Consult your control system documentation.

In the case of Siemens Step7, the GSD import can be done as follows; Open the step 7 HW config and close the current project file. Select "Install New GSD" from the "Options" menu and browse to the location of the **Nel_06CA.gsd**. See figures 1 and 2.

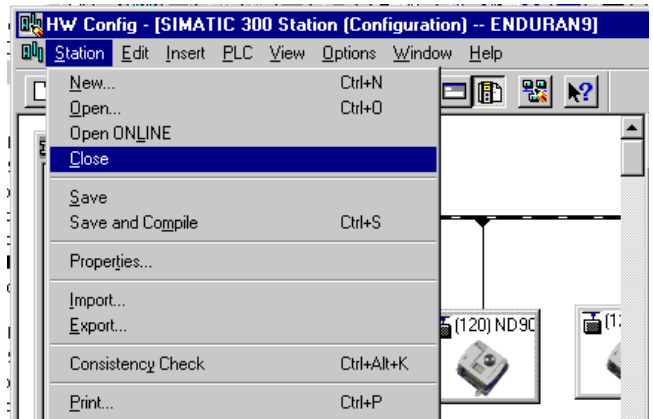


Figure 1. Step 7 HW config.



Figure 2. Install New GSD.

After the installation, the ND9000P GSD can be found from the GSD Catalog. See figure 3.

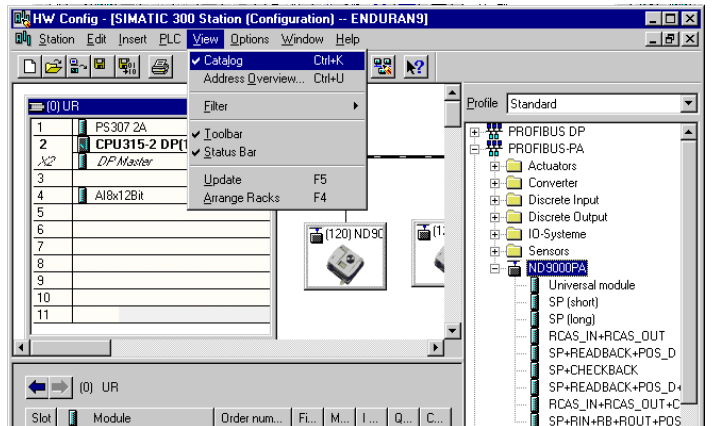


Figure 3. GSD catalog.

2.2 Cyclic communication configuration

The process control communication between the control system and the ND9000P can be configured using the GSD modules.

GSD module is a set of data, which the control system and the ND9000P exchanges cyclically. The ND9000P GSD modules are listed in the table 1.

Table 1. ND9000P GSD modules.

GSD module name	control system output	control system input
SP (short)	bytes 1-4: SP.VALUE: Valve position setpoint in AO block AUTO mode (default mode), IEEE-754 float byte 5: SP.STATUS: The status of the valve position setpoint. Unsigned integer 8. In normal case, use value 0x80. See table 2.	none
SP (long)	bytes 1-4: SP.VALUE: Valve position setpoint, IEEE-754 float byte 5: SP.STATUS: The status of the valve position setpoint. Unsigned integer 8. In normal case, use value 0x80. See table 2.	none
RCAS_IN+RCAS_OUT	bytes 1-4: RCAS_IN.VALUE: Valve position setpoint in RCAS mode, IEEE-754 float byte 5: RCAS_IN.STATUS: The status of the valve position setpoint. Unsigned integer 8. See table 2.	bytes 1-4: RCAS_OUT.VALUE: Feeds back the SP or RCAS_IN, depending on the mode, IEEE-754 float byte 5: RCAS_OUT.STATUS: Unsigned integer 8. See table 2.
SP+READBACK+POS_D	bytes 1-4: SP.VALUE: Valve position setpoint in AO block AUTO mode (default mode), IEEE-754 float byte 5: SP.STATUS: The status of the valve position setpoint. Unsigned integer 8. In normal case, use value 0x80. See table 2.	bytes 1-4: READBACK.VALUE: Valve position measurement, IEEE-754 float. byte 5: READBACK.STATUS: The status of the valve position measurement. Unsigned integer 8. See table 2. byte 6: POS_D.VALUE: Limit information from the limit switches or calculated from the position sensor. Unsigned integer 8. The values are: 1 = closed 2 = opened 3 = intermediate byte 7: POS_D.STATUS: Unsigned integer 8.
SP+CHECKBACK	bytes 1-4: SP.VALUE: Valve position setpoint in AO block AUTO mode (default mode), IEEE-754 float byte 5: SP.STATUS: The status of the valve position setpoint. Unsigned integer 8. In normal case, use value 0x80. See table 2.	Bytes 1-3: CHECKBACK: diagnostic signal, bit-enumerated, 3 bytes. See table 3.
SP+READBACK+POS_D+CHECKBACK	bytes 1-4: SP.VALUE: Valve position setpoint in AO block AUTO mode (default mode), IEEE-754 float byte 5: SP.STATUS: The status of the valve position setpoint. Unsigned integer 8. In normal case, use value 0x80. See table 2.	bytes 1-4: READBACK.VALUE byte 5: READBACK.STATUS byte 6: POS_D.VALUE byte 7: POS_D.STATUS bytes 8-10: CHECKBACK
RCAS_IN+RCAS_OUT+CHECKBACK	bytes 1-4: RCAS_IN.VALUE: Valve position setpoint in RCAS mode, IEEE-754 float byte 5: RCAS_IN.STATUS: The status of the valve position setpoint. Unsigned integer 8. See table 2.	bytes 1-4: RCAS_OUT.VALUE: Feeds back the SP or RCAS_IN, depending on the mode, IEEE-754 float byte 5: RCAS_OUT.STATUS: Unsigned integer 8.

GSD module name	control system output	control system input
		bytes 6-8: CHECKBACK
SP+RIN+RB+ROUT+POS_D+CB	bytes 1-4: SP.VALUE: Valve position setpoint in AO block AUTO mode (default mode), IEEE-754 float byte 5: SP.STATUS: The status of the valve position setpoint. Unsigned integer 8. In normal case, use value 0x80. See table 2. bytes 6-9: RCAS_IN.VALUE: Valve position setpoint in RCAS mode, IEEE-754 float byte 10: RCAS_IN.STATUS: The status of the valve position setpoint. Unsigned integer 8. See table 2.	bytes 1-4: READBACK.VALUE byte 5: READBACK.STATUS bytes 6-9: RCAS_OUT.VALUE byte 10: RCAS_OUT.STATUS byte 11: POS_D.VALUE byte 12: POS_D.STATUS bytes 13-15: CHECKBACK

The STATUS byte and the CHECKBACK mappings are listed in the tables 2 and 3.

Table 2. Status byte mapping.

Table 2: Status byte mapping:									
Status byte in case that the limit bits are zeros	Quality		Additional information				Limit		Meaning
	Bits		Bits				Bits		
	7	6	5	4	3	2	1	0	
0x00	0	0	0	0	0	0	x	x	bad
0x04	0	0	0	0	0	1	x	x	bad, configuration error
0x08	0	0	0	0	1	0	x	x	bad, not connected
0x0C	0	0	0	0	1	1	x	x	bad, device failure
0x10	0	0	0	1	0	0	x	x	bad, sensor failure
0x14	0	0	0	1	0	1	x	x	bad, no communication (last usable value)
0x18	0	0	0	1	1	0	x	x	bad, no communication (no usable value)
0x1C	0	0	0	1	1	1	x	x	bad, out of service
0x40	0	1	0	0	0	0	x	x	uncertain
0x44	0	1	0	0	0	1	x	x	uncertain, last usable value
0x48	0	1	0	0	1	0	x	x	uncertain, substituted value
0x4C	0	1	0	0	1	1	x	x	uncertain, initial value
0x80	1	0	0	0	0	0	x	x	good
0x84	1	0	0	0	0	1	x	x	good, Update event (change of parameters)
0xA0	1	0	1	0	0	0	x	x	good, go into failsafe position (command)
0xA4	1	0	1	0	0	1	x	x	good, maintenance required
0xC0	1	1	0	0	0	0	x	x	good (cascade)
0xC4	1	1	0	0	0	1	x	x	good (cascade), initialization confirmed
0xC8	1	1	0	0	1	0	x	x	good (cascade), initialization requested
0xCC	1	1	0	0	1	1	x	x	good (cascade), rcas mode not requested
0xD8	1	1	0	1	1	0	x	x	good (cascade), local operation has priority
0xE0	1	1	1	0	0	0	x	x	good (cascade), go into failsafe position (command)
	x	x	x	x	x	x	0	0	value is not limited
	x	x	x	x	x	x	0	1	value is low limited
	x	x	x	x	x	x	1	0	value is high limited
	x	x	x	x	x	x	1	1	value is constant

x = could be any (0 or 1)

Table 3. CHECKBACK signal bit-enumeration.

Byte	Bit	Description	Indication Class
0	0	Field device in Fail safe active	R
	1	Request for local Operation	R
	2	Field device under local control, LOCKED OUT switch is in gear	R
	3	Emergency override active	R
	4	Actual position feedback different from expected position	R
	5	Indicates that the torque limit in OPEN direction is exceeded	R
	6	Indicates that the torque limit in CLOSE direction is exceeded	R
	7	Indicates status of travel monitoring equipment, if YES, travel time for actuator has exceeded.	A
1	0	Actuator is moving towards open direction	R
	1	Actuator is moving towards close direction	R
	2	The alert generated by any change to the static data (Function and Transducer Block).	A
	3	Simulation of process values is enabled	R
	4	-	-
	5	Internal control loop disturbed	R
	6	Positioner inactive (OUT status = BAD)	R
	7	Device under selftest	R
2	0	Indicates that total valve travel limit is exceeded	R
	1	Indicates that an additional input (i.e. for diagnostics) is activated	R
	2...7	-	

R Indication, remains active as long as the reason for the message exists.

A Indication, will be automatically reset after 10s.

2.3 Simatic PDM Driver installation

ND9000P simatic PDM driver (Electronic Device Description) installation instructions;

1. Download the latest ND9000F support file package from www.neles.com/ND9000.
2. Use Winzip to extract the package to temporary folder.
3. Run the **DeviceInstall.exe** from the temporary folder.
4. After successful installation, ND9000P objects should be listed in the Simatic PDM PA-Device Catalog, see figure 4.
5. There are two objects for different software revisions. The ND9000P software revision (**Fbi sw revision**) can be checked from the device status window, see page 20. If the software revision is not known while selecting the PDM object, select the latest one, check the revision from the status window and change the object if needed.

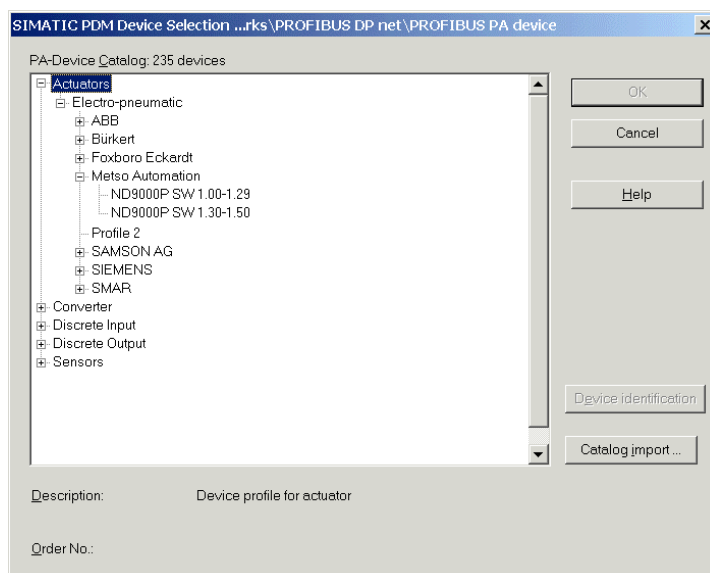


Figure 4. Simatic PDM PA-Device Catalog.

2.4 Basic set-up steps

Follow these steps to get the valve package up and running.

1. Make the physical valve package installation according to the ND9000 Installation, Maintenance and Operating Instructions (IMO).
2. Set the assembly related parameters, see page 8 and IMO.
3. Run the automatic travel calibration and the position control tuning, see page 12.
4. Check if the device status is OK, see page 16.

3 PDM user interface

The ND9000P Simatic PDM user interface is divided in three main categories.

- **Parameter groups.** The static configuration parameters are grouped in logical groups. The parameters in the groups are presented in the parameter table. The parameter table can be saved to the Hard Disk. The saved parameter table can be compared with the parameters in the device.
- **Device menu.** Device menu contains high-level device functions like Calibration.
- **View menu.** Unlike the Device menu, the View menu contains only passive elements, such as measured value displays.

3.1 Parameter groups

The parameter groups are shown in the figure 5.

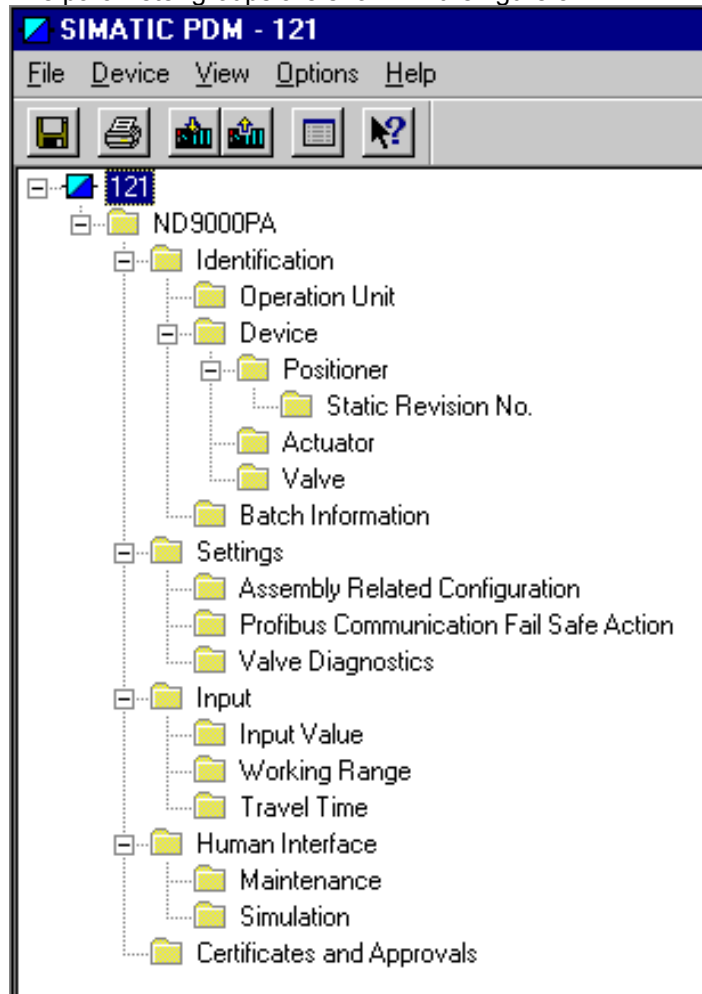


Figure 5. Parameter groups.

3.1.1 Identification

3.1.1.1 Operation Unit

TAG

Text; can be used in any way. A recommended use is as a unique label for a field device in the plant.

Descriptor

Text that is associated with the Field Device. This text can be used by the user in any way. There is no specific recommended use.

Message

Text that is associated with the Field Device. This text can be used by the user in any way. There is no recommended use.

3.1.1.2 Device

3.1.1.2.1 Positioner

Manufacturer

References a specific manufacturer, which is usually a company name, that is responsible for the manufacture of this Field Device.

Device ID

Uniquely identifies the Field Device when combined with the Manufacturer Identification and Device Type. Therefore, this variable cannot be modified by the Host user.

Device Serial Num

Device serial number that can be found from the positioner machine plate.

Installation Date

The Installation date of the device.

Profile Revision

Revision number of the profile relating to the block.

PROFIBUS Ident Number

Each PROFIBUS-DP device shall have an Ident Number provided by the PNO. There are profile specific Ident Numbers. A device may have a profile specific one and the manufacturer specific one. The user is able to choose one of both using this parameter. Options are

- Profile specific (0x9710)
- Manufacturer specific (0x06CA) (Default)

NOTE

The Ident Number can be changed only when the cyclic communication is not active.

3.1.1.2.1.1 Static Revision No

Physical Block, Transducer Block, Function Block

The revision level of the static data associated with the block. The Static Revision No. is changed by the device each time a static parameter is changed in value.

3.1.1.2.2 Actuator

Manufacturer

References a specific manufacturer, which is usually a company name, that is responsible for the manufacture of this Field Device.

Actuator Class

Actuator class indication.

Actuator Type

Actuator type indication. Options are

- Undefined
- Double acting actuator
- Single acting actuator

Actuator Fail Action

Actuator fail safe position during LOSS OF SUPPLY PRESSURE. This parameter is informational only.

- Not initialized
- Opening
- Closing
- None (Double acting actuator)

Serial Number

Actuator serial number can be written here.

3.1.1.2.3 Valve

Manufacturer

References a specific manufacturer, which is usually a company name, that is responsible for the manufacture of this Field Device.

Valve Type

Valve type indication. Options are

- Linear
- Rotary, part-turn
- Neles CV globe
- Undefined

Serial Number

Valve serial number can be written here.

3.1.1.3 Batch Information

Batch ID

Identifies a certain batch to allow assignment of equipment-related information (e.g. faults, alarms ...) to the batch.

Batch Unit

Identifies the active Control Recipe Unit Procedure or the related Unit (e.g. reactor, centrifuge, drier).

Batch Operation

Identifies the active Control Recipe Operation.

Batch Phase

Identifies the active Control Recipe Phase.

3.1.2 Settings

3.1.2.1 Assembly Related Configuration

NOTE:

The following parameters are assembly related. In order to proper operation of the device, these parameter values must match with the physical valve package.

See ND9000 Installation, Maintenance and Operating Instructions for details.

Performance Level

Target performance level of the valve position control. Options are;

- Aggressive; In order to optimise the control performance the device immediate response to signal changes, overshoots
- Over tuned; Fast response to signal changes, small overshooting
- Optimum; Very small overshoot with minimum step response time

- Stable; No overshooting, slow response to input signal changes
- Max stability; No overshooting, deadband may increase, slow but stable behaviour

Positioner Fail Action

Configuration of the action taken during the LOSS OF SUPPLY POWER (supply pressure is available). This action will also take place when the positioner software discovers a fatal device failure. In these both cases the spool valve feeds C1 (pneumatic connector) and releases C2 pressure. Options are;

- Undefined
- Close
- Open

Set value Close for double acting actuators. For single acting actuators set value in the spring direction.

NOTE:

Perform valve calibration and tuning always when this parameter has been changed.

Position Sensor Rotation

Defines relationship between the position sensor rotation and valve action. Options;

- Undefined
- Standard : Clockwise to close
- Nonstandard : Counter clockwise to close

Actuator Type

Actuator type indication. Options are

- Undefined
- Double acting actuator
- Single acting actuator

Actuator Fail Action

Actuator fail safe position during LOSS OF SUPPLY PRESSURE. This parameter is informational only.

- Undefined (Double acting actuator)
- Opening
- Closing

Valve Type

Valve type selection. Options are

- Linear
- Rotary, part-turn
- Neles CV globe
- Undefined

Dead Angle Compensation

The α_0 setting is made for Neles segment and ball valves. This setting takes into account the "dead angle" α_0 of the ball valves. The entire signal range is then used for effective valve opening $90^\circ - \alpha_0$.

Limit switches

This parameter defines either the limit switches are installed or not. Options are;

- Not installed (default)
- Installed

If the limit switches are not installed, the POS_D.VALUE is calculated based on the position sensor measurement. The closed and open limits are 2% and 98%.

3.1.2.2 Profibus Communication Fail Safe Action

Fail Safe Mode

Defines reaction of device if communication fault is still detected after fail safe time. Options are

- Fail Safe Value is used as control regulator input
- Storing last valid setpoint
- Positioner does Positioner Fail Action

Fail Safe Time

Time in seconds from detection of failure in output block up to the output action of the block output if the condition still exists.

Fail Safe Default Value

Default Value for the setpoint input if communication fault is detected.

3.1.2.3 Valve Diagnostics

Valve total travel warning limit

Warning limit for valve total travel.

Valve reversals warning limit

Warning limit for valve reversals.

Actuator total travel warning limit

Warning limit for actuator total travel.

Actuator reversals warning limit

Warning limit for actuator reversals.

Spool valve travel warning limit

Warning limit for spool valve total travel.

Spool valve reversals warning limit

Warning limit for spool valve reversals.

Steady state deviation warning limit

Warning limit for steady state deviation. Steady state deviation average value is checked against the warning limit with 24 hour intervals. If the limit is exceeded, warning is activated.

Steady state deviation alarm limit

Online alarm limit for steady state deviation. Steady state deviation measurement has to be over this limit value for a time indicated by Steady state deviation latch time.

Steady state deviation latch time

Online alarm activation time for steady state deviation

Dynamic state deviation warning limit

Warning limit for dynamic deviation. Dynamic deviation average value is checked against the warning limit with 24 hour intervals. If the limit is exceeded, warning is activated.

Stiction lo warning limit

Low warning limit for stiction. Stiction average value is checked against the warning limit with 24 hour intervals. If the limit is exceeded, warning is activated.

Stiction hi warning limit

High warning limit for stiction. Stiction average value is checked against the warning limit with 24 hour intervals. If the limit is exceeded, warning is activated.

Stiction lo alarm limit

Online low alarm limit for stiction. Stiction measurement has to be below this limit value for a time indicated by STICTION_LATCH_NBR.

Stiction hi alarm limit

Online high alarm limit for stiction. Stiction measurement has to be above this limit value for a time indicated by Stiction latch number.

Stiction latch number

Online alarm activation number for stiction.

Load for opening lo warning limit

Low warning limit for load for opening. Load for opening average value is checked against the warning limit with 24 hour intervals. If the limit is exceeded, warning is activated.

Load for opening hi warning limit

High warning limit for load for opening. Load for opening average value is checked against the warning limit with 24 hour intervals. If the limit is exceeded, warning is activated.

Load for opening lo alarm limit

Online low alarm limit for load for opening. Load for opening measurement has to be below this limit value for a time indicated by Load for opening latch number.

Load for opening hi alarm limit

Online high alarm limit for load for opening. Load for opening measurement has to be above this limit value for a time indicated by Load for opening latch number.

Load for opening latch number

Online alarm activation number for load for opening.

Supply pressure lo alarm limit

Online alarm low limit for supply pressure. Supply pressure measurement has to be below this limit value for a time indicated by Supply pressure latch time.

Supply pressure hi alarm limit

Online alarm high limit for supply pressure. Supply pressure measurement has to be above this limit value for a time indicated by Supply pressure latch time.

Supply pressure latch time

Online alarm activation time for supply pressure.

Device temperature lo alarm limit

Online alarm low limit for circuit board temperature. Temperature measurement has to be below this limit value for a time indicated by Device temperature latch time.

Device temperature hi alarm limit

Online alarm high limit for circuit board temperature. Temperature measurement has to be above this limit value for a time indicated by Device temperature latch time.

Device temperature latch time

Online alarm activation time for temperature.

Communication fail rate alarm limit

Alarm limit for fieldbus communication failure.

Total operation time warning limit

Warning limit for total operation time.

3.1.3 Input

3.1.3.1 Input value

Direction

Direction of positioner. Options are

- Rising (increasing of setpoint input results in opening of the valve)
- Falling (increasing of setpoint input results in closing of the valve)

Lower Value

Defines the operational lower range value of the input value (0%) in engineering units.

Upper Value

Defines the operational upper range value of the input value (100%) in engineering units.

Unit (Input)

The engineering unit of the input value.

ND9000 supports signal cutoff and limiting in both ends of the operating range. The configuration parameters are; **Low cutoff**, **Low limit**, **High cutoff** and **High limit**.

- If the input signal is smaller than low cutoff, the valve will be fully closed.
- If the input signal is smaller than low limit, the valve stays in the low limit.
- If the input signal is greater than high cutoff, the valve will be fully opened.
- If the input signal is greater than high limit, the valve stays in the high limit.

The cutoff **overrides** the limit as follows;

- If the low cutoff > low limit, the low limit is not active.
- If the low cutoff < low limit, both low cutoff and limit are active.
- If the low cutoff is set to zero, the low cutoff is not active.
- If the high cutoff < high limit, the high limit is not active.

- If the high cutoff > high limit, both high cutoff and limit are active.
- If the high cutoff is set to 100%, the high cutoff is not active.

3.1.3.2 Working Range

Lower Value

Lower Value (Output Signal Range): Lower range value of the process variable (0%) in engineering units.

Upper Value

Upper Value (Output Signal Range): Upper range value of the process variable (100%) in engineering units.

Unit (Output)

The engineering unit that the output value is reported in.

3.1.3.3 Travel Time

Travel Time CLOSE

Setpoint for the time in seconds between the change of the state from OPEN to CLOSED.

Travel Time OPEN

Setpoint for the time in seconds between the change of the state from CLOSED to OPEN.

3.1.4 Human Interface

3.1.4.1 Maintenance

Calibration Date

Date of last calibration of the device.

Configuration Date

Date of last configuration of the device.

Maintenance Date

Date of last valve maintenance.

3.1.4.2 Simulation

Simulation

Enable or disable the simulation function.

Simulation Value

For commissioning and maintenance reasons, it is possible to simulate the Readback by defining the value and the status. This means that the Transducer Block and the Function Block will be disconnected.

Quality

Signal quality information.

Limit

Signal limit information.

3.1.5 Certificates and Approvals

Device Certification

Certification of the device.

3.2 Device menu

The device menu contents is shown in the figure 6.

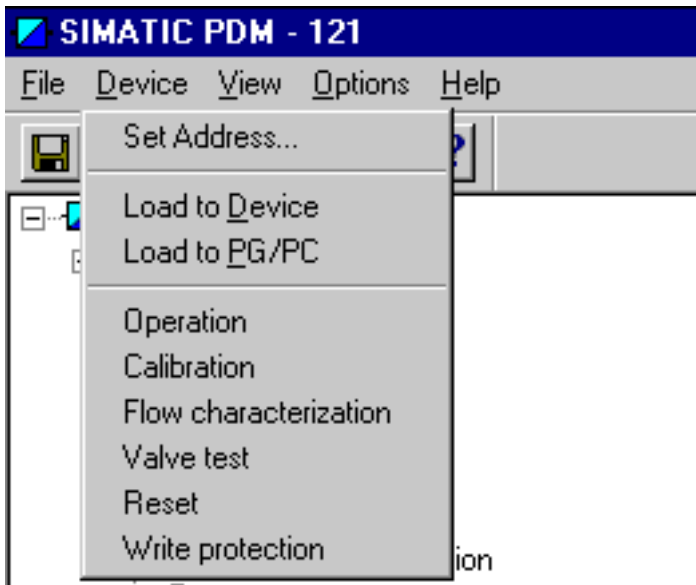


Figure 6. Device Menu

3.2.1 Operation

3.2.1.1 Page AUTO

The page AUTO in the operation window is presented in figure 7. From this window it is possible to change the operating mode of the device and change the value of the auto-mode valve position setpoint (SP).

If the cyclic communication is running and it is using a GSD module that has the SP included, it is not possible to write the Setpoint from here.

If it is desired to control the valve independent of the control system, see page MAN.

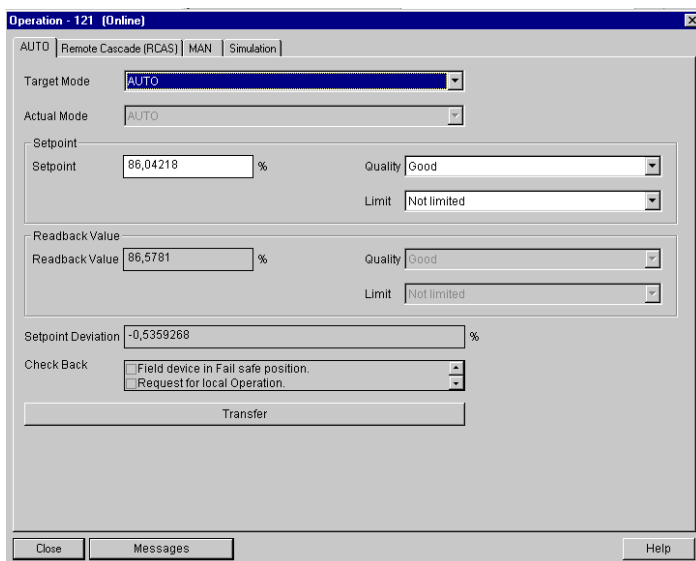


Figure 7. Operation / Auto.

3.2.1.2 Page Remote Cascade

The page Remote Cascade in the operation window is presented in figure 8. From this window it is possible to change the operating mode of the device and change the value of the RCAS-mode valve position setpoint (RCAS_IN).

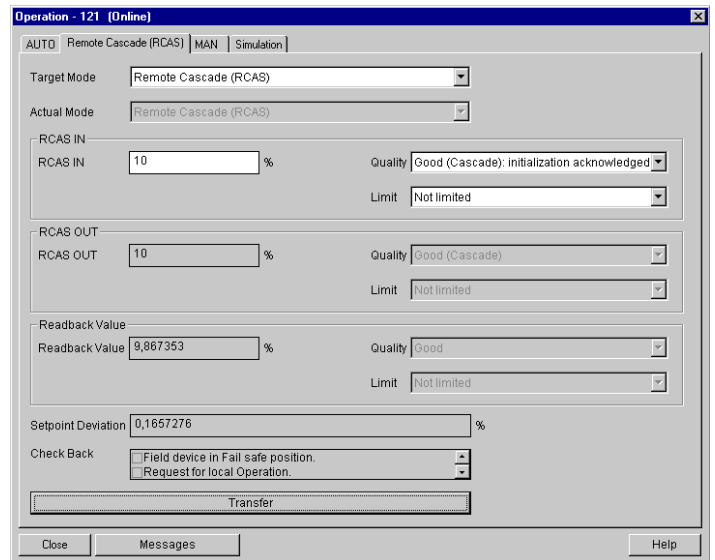


Figure 8. Operation / RCAS.

3.2.1.3 Page MAN

The page MAN in the operation window is presented in figure 9. From this window it is possible to change the operating mode of the device and change the value of the manual-mode valve position setpoint (OUT).

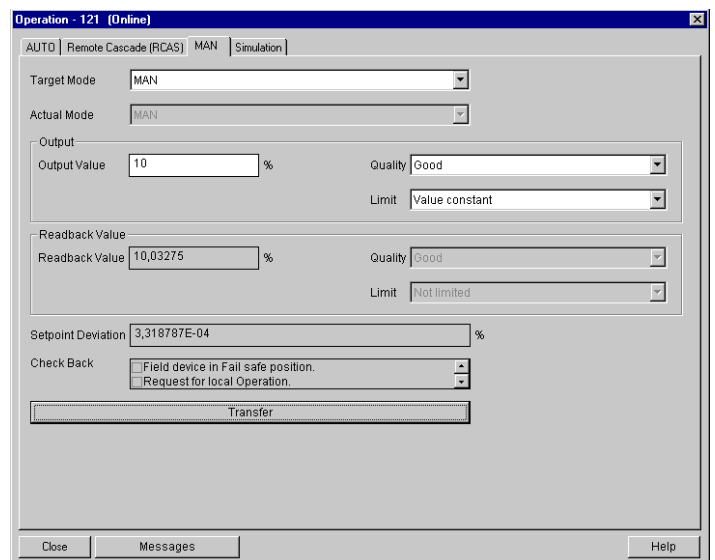


Figure 9. Operation / MAN.

3.2.1.4 Page Simulation

The page Simulation in the operation window is presented in figure 10. From this window it is possible to enable/disable the simulation function and simulate the Readback value and status.

When simulation is enabled, the Analog Output Block and the Transducer Block are disconnected. The simulation value and status are copied to the AO Block Readback signal. Simulation is useful during the device commissioning and maintenance.

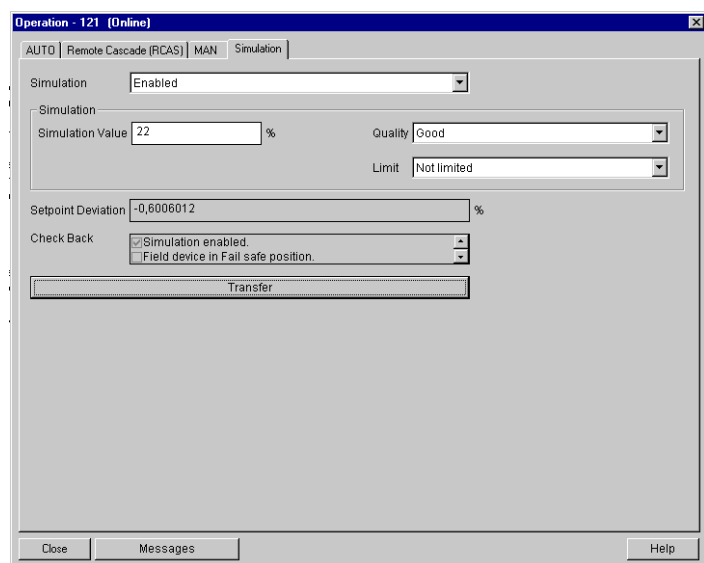


Figure 10. Operation / Simulation.

3.2.2 Calibration

The calibration window is presented in figure 11.

Before starting the calibration, check that the assembly related parameters (page 8) match with the physical installation of the device.

The calibration procedure can be started by clicking one of the three Start buttons. It is possible to run the automatic travel calibration and the position control tuning either both at the same time or separately. The calibration can be stopped any time by clicking the Cancel button.

Once the calibration has been started, the on-line calibration status is shown in the "Calibration Status" parameter.

If the calibration fails, the reason for the failure is reported in the parameter "Calibration error code". After the failed calibration, first check the assembly related parameters. If the parameters are correct, see ND9000P Installation, Maintenance and Operating Instructions (IMO) for further information.

FOR SAFETY'S SAKE: Calibration moves the valve from a closed position to a fully open position. Check that you are allowed to perform calibration, and that it will not endanger people or processes.

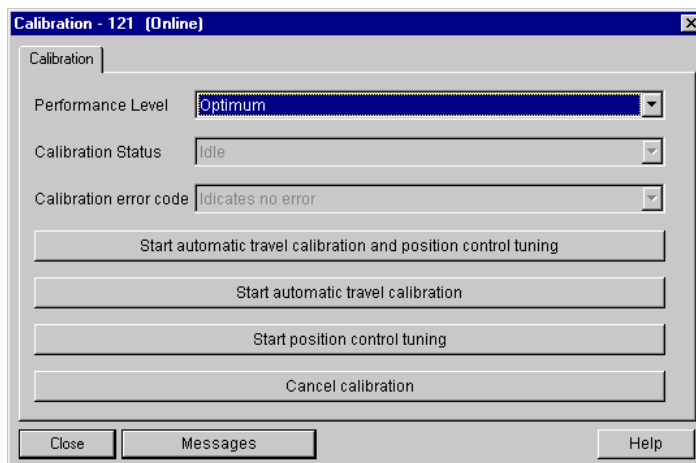


Figure 11. Calibration.

3.2.3 Flow characterization

The Flow modification allows you to modify the flow characteristics curve of the valve to improve controllability of the valve and optimise control loop performance.

The characterisation window is presented in figure 12.

There are three options for Flow characterization

- **No characterization:** Characterization is not used
- **Characterization polynomial:** Flow Modification is used. If you select this option, enter a Polynomial Factor value.
- **User defined curve:** Flow Modification is used. If you select this option, enter the user defined curve values (21 values) in the page User table.

Polynomial Factor describes the nearest approximate or the exact shape of the valve characterization transfer function based on the following hyperbolic function:

$$f(x) = x/(S+x(1-S)), \text{ where}$$

S = Polynomial Factor

x = normalized (0-100%) Setpoint value

f(x) = an intermediate calculation of the Target Position.

- If Polynomial Factor is **between 0 and 1**, a quick opening transfer function is applied.
- If Polynomial Factor is **1**, a linear transfer function is applied.
- If Polynomial Factor is **larger than 1**, an equal percentage transfer function is applied.

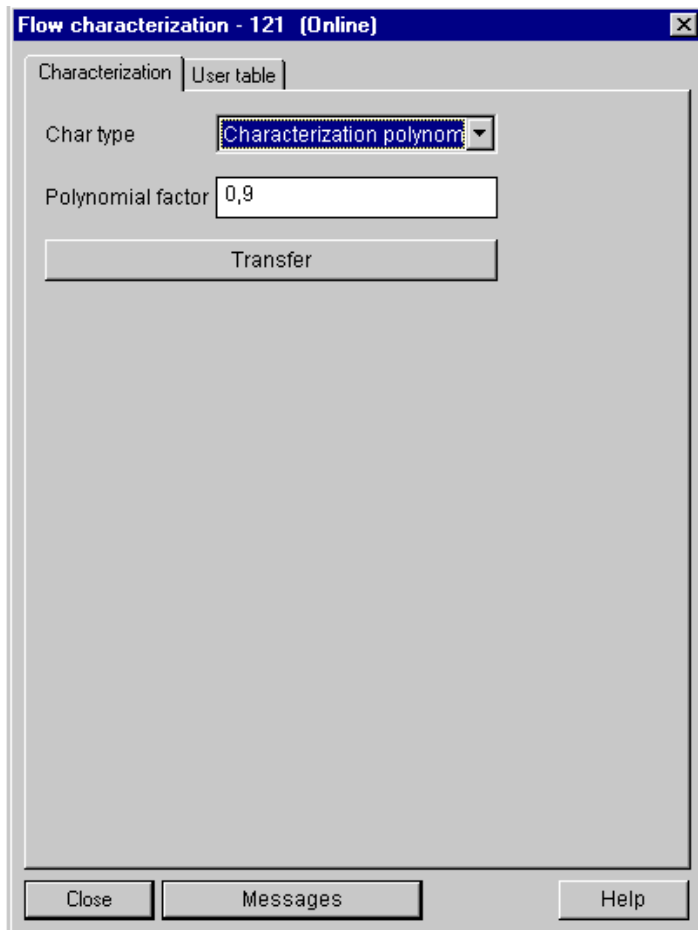


Figure 12. Flow characterisation.

3.2.4 Valve test

Offline tests evaluate the performance of the control valve. The tests are performed by the device itself without any change in input signal from the system.

NOTE: Control valve testing affects process control by driving the control valve independently of the input signal from the control system.

You can use the test results to diagnose the condition of the control valve. These test results reveal future maintenance needs. Run the control valve test regularly to ensure optimal performance of the control valve in every situation.

Read through this section to gain a thorough understanding of the Testing procedures.

3.2.4.1 Step Test

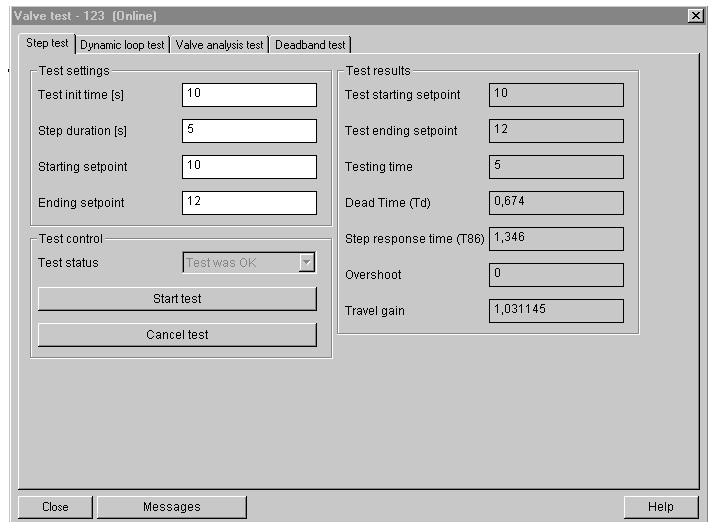


Figure 13. Step test.

You can control the Step test by entering the following parameters in the Step Test view:

- **Test Init Time:** The time given to valve to reach starting point of the Step test
- **Step duration:** Duration time of the step. The total test time is **Init Time + Step Duration**.
- **Start Position:** Starting valve position for the Step test
- **End Position:** Ending position of the valve

You can start the test by clicking the "Start test" button. The test can be stopped any time by clicking the "Cancel test" button.

Once the test has been run, the following test results are calculated.

- **Dead Time Td (s):** The time that the valve requires to move at least 0.005% after the input signal change has occurred.
- **Step Response Time T86 (s):** The time elapsed when the valve reaches 86.5% of the realized step size (not the nominal stepwise change in the setpoint)
- **Overshoot:** The size of overshoot as a percentage of the realized step.
- **Travel Gain:** The ratio between the step size of the control signal and the position measurement. In optimum case the value is 1.0.

3.2.4.2 Dynamic Loop Test

Figure 14 shows Dynamic Loop test.

Figure 14. Dynamic Loop test.

You can control the Dynamic Loop test by entering the following parameters in Dynamic Loop Test view:

- **Test Init Time:** The time given to valve to reach the starting point of the test
- **Ramp Time:** Duration of ramp time. Total test time is then **Init Time + 2*Ramp Time**
- **Start Position:** Starting setpoint for test
- **End Position:** Ending setpoint for test. Note that the end setpoint may be smaller than the start setpoint. In that case, the loop runs downwards in time.

You can start the test by clicking the "Start test" button. The test can be stopped any time by clicking the "Cancel test" button.

Once the test has been run, the following test results are calculated.

- **Maximum Dynamic Error Band:** The maximum difference in valve travel for any single setpoint value during the loop. The value is calculated by the device from the loop size minus 10% from the start and 10% from the end.
- **Setpoint at max error (%):** The value of the setpoint at the point at which Maximum Dynamic Error Band is measured.

3.2.4.3 Valve Analysis Test

Figure 15 shows Valve Analysis test.

Figure 15. Valve Analysis test.

You can control the Valve Analysis test by entering the following parameters in Valve Analysis Test view:

- **Test Init Time:** The time given to valve to reach the 0% position.
- **Ramp Time:** Duration of ramp time. Total test time is then **Init Time + 4*Ramp Time + 2*Steady Time**.
- **Start setpoint:** Measurement point of hysteresis, a position at which the valve stops for static hysteresis measurement.
- **Steady Time:** Used to store the steady time in the hysteresis position. This is also the amount of time in that the test is held in the 100% position before the descending ramp is started.

You can start the test by clicking the "Start test" button. The test can be stopped any time by clicking the "Cancel test" button.

Once the test has been run, the following test results are calculated.

- **Static Hysteresis:** During the steady time, the last 80 msec valve position is averaged in the opening ramp. The same average is calculated while closing the valve. The hysteresis is the difference of these values.
- **Sensitivity:** A percentage of change in input signal that is measured when the valve starts moving again after the steady state of the opening ramp is completed.
- **Load for Opening:** The pressure difference (in bars) recorded when the valve starts to move from a closed position.
- **Seat Load:** The absolute pressure difference in bars between the supply pressure (spring to open) or air pressure (spring to close) and the pressure at which the valve first closes.
- The **stroking range** is the pressure required to stroke the valve assembly from the open to the closed position and back.
- ❑ **Stroking range o2c close;** The pressure difference (in bars) recorded when the valve starts to move from position 1% to closed direction.
- ❑ **Stroking range o2c open;** The pressure difference (in bars) recorded when the valve starts to move from po-

sition 99% to closed direction.

- ❑ **Stroking range c2o close;** The pressure difference (in bars) recorded when the valve starts to move from position 1% to open direction.
- ❑ **Stroking range c2o open;** The pressure difference (in bars) recorded when the valve starts to move from position 99% to open direction.

3.2.4.4 Valve Deadband Test

Figure 16 shows Valve Deadband test.

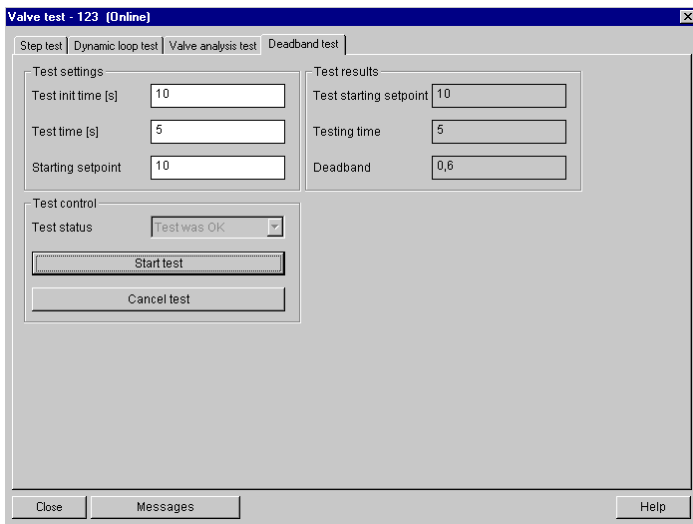


Figure 16. Valve Deadband test.

You can control the Valve Deadband test by entering the following parameters in Valve Deadband Test view:

- **Test Init Time:** The time given to valve to reach starting point of the valve deadband test
- **Test Time:** The time that the test waits between successive 0.1% steps. The total test time can not be estimated. The absolute maximum is $40 \times \text{Test Time}$. Note that when the input signal direction changes, the wait time is $2 \times \text{Test Time}$.
- **Start setpoint:** Starting valve position for the valve deadband test

You can start the test by clicking the "Start test" button. The test can be stopped any time by clicking the "Cancel test" button.

Once the test has been run, the following test results are calculated.

- **Deadband:** The range through which a control valve's input signal may be varied, upon reversal of direction, without initiating an observable change in the position of the closure member.

3.2.5 Reset

Reset Diagnostics allows you to choose the diagnostics parameters you wish to reset. After you reset the diagnostics, old data is permanently deleted.

- Valve travel counters

- Actuator travel counters
- Setpoint travel counters
- Spool valve travel counters
- Reset all trends and speed histograms
- Valve travel vs. time histogram
- Event log
- Reset everything

Factory Reset provides three different reset functions.

- Factory Reset resets device parameters to default values. The bus address remains the same.
- Warmstart of the device. All parametrisation remains unchanged.
- Reset the bus address to value 126.

3.2.6 Write Protection

HW Write Protection. Indicates the position of a hardware jumper which protects all acyclic write access to all writeable parameters of a device.

SW Write Locking. Protects all acyclic write access to all writeable parameters of a device except this SW Write Locking one. Selections are On and Off (default).

3.3 View menu

The contents of the view menu is presented in figure 17.

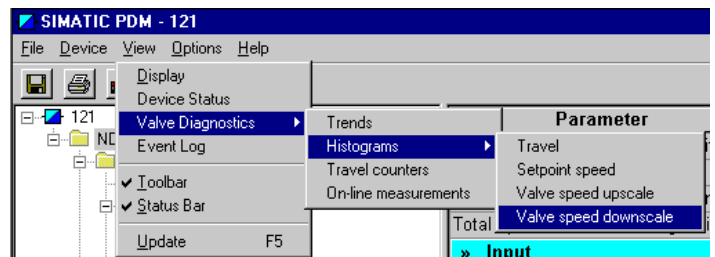


Figure 17. View menu.

3.3.1 Display

The page Measured value is presented in figure 18.

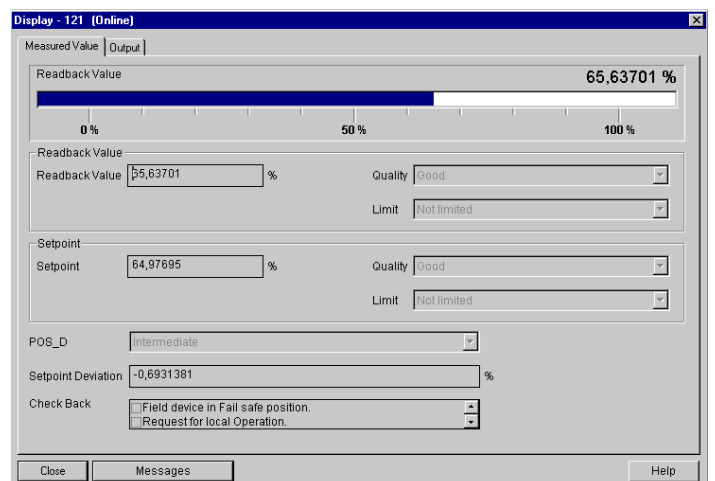


Figure 18. Measured value.

Readback value is the valve position measurement.

Setpoint is the current value of the AUTO mode setpoint, written by the control system or entered by user.

POS_D displays the limit information that is either copied from the limit switches or calculated from the position sensor.

The page Output is presented in figure 19.

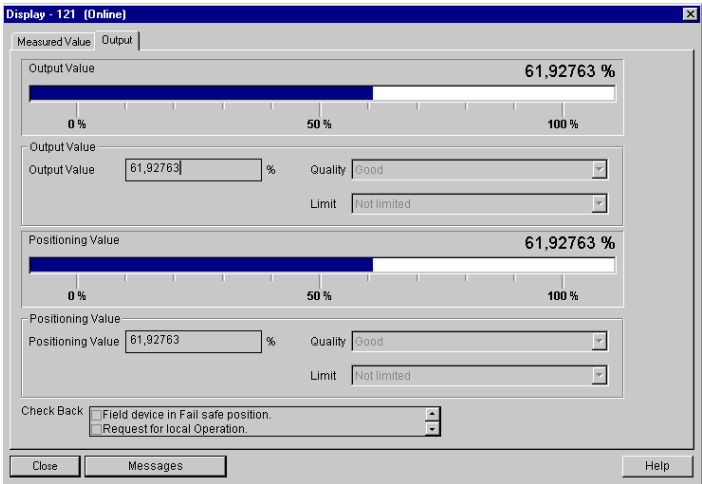


Figure 19. Page Output.

Output Value is the AO block output value. This value is user writable only in manual mode.

Positioning value is the final valve position control (servo control) setpoint. The possible difference between this value and Output is due to signal modifications, such as characterization, dead angle compensation, cutoff and limiting.

3.3.2 Device Status

The device status window reports the device revision numbers, serial numbers and active warnings and alarms.

The Device status window is presented in figure 20.

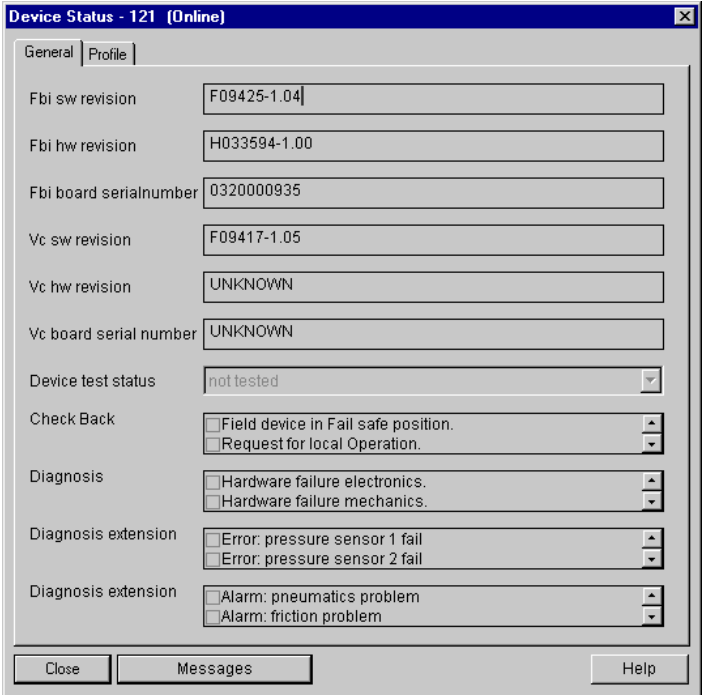


Figure 20. Device status window.

3.3.3 Valve Diagnostics

3.3.3.1 Trends

Trends are continuously saved in the device memory. Trends show the previous 30 full days, 12 full months, and up to 25 full years. In addition, trends show a **Now** value, which is the average value of the previous 0-24 hours. Figure 21 shows a sample trend.

Trend selector parameter is used to select the trend that is shown in the pages "Last 30 days", "Last 12 months" and "Last 25 years".

Trends status displays the status of the current trend reading procedure.

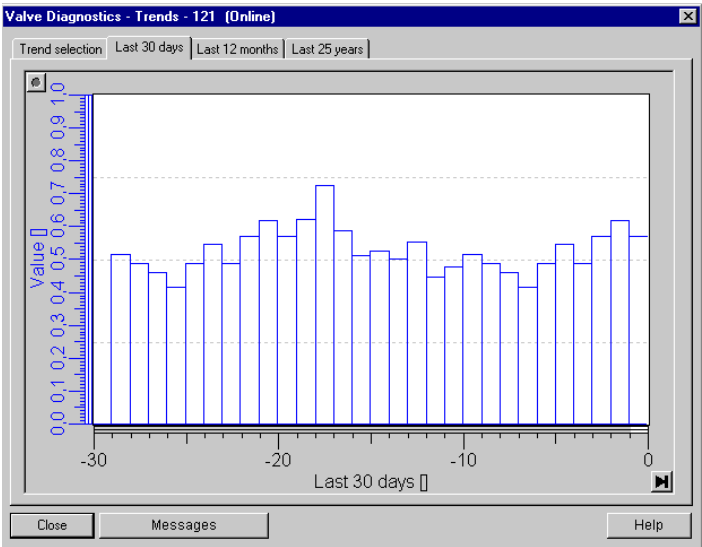


Figure 21. A sample trend graph

3.3.3.1.1 Time Axis

The time axis of the trend is from left to right, with oldest values on the left and newest values on the right. The trend adjusts periodically along the time axis as follows:

- When 24 hours have passed, a new **Day** value is added to the trend and the device begins calculating a new **Now** value.
- When 30 days have passed, a new **Month** value is added to the trend.
- When 12 months have passed and 12 new **Month** values have been calculated, a new **Year** value is added to the trend.

3.3.3.1.2 Reference Value

Reference value represents valve performance at its best. During the first three months of operation, the device calculates reference values for all trends. Note that the device does not calculate reference values if supply pressure is not connected.

You can use reference values later for analyzing changes in the trend.

3.3.3.1.3 Steady State Deviation

Steady State Deviation is used to determine the basic control accuracy of the valve. It is updated whenever the setpoint is considered to have reached the desired position as precisely as possible. Figure 22 illustrates this concept. Steady State Deviation trend is updated during the periods marked **steady**.

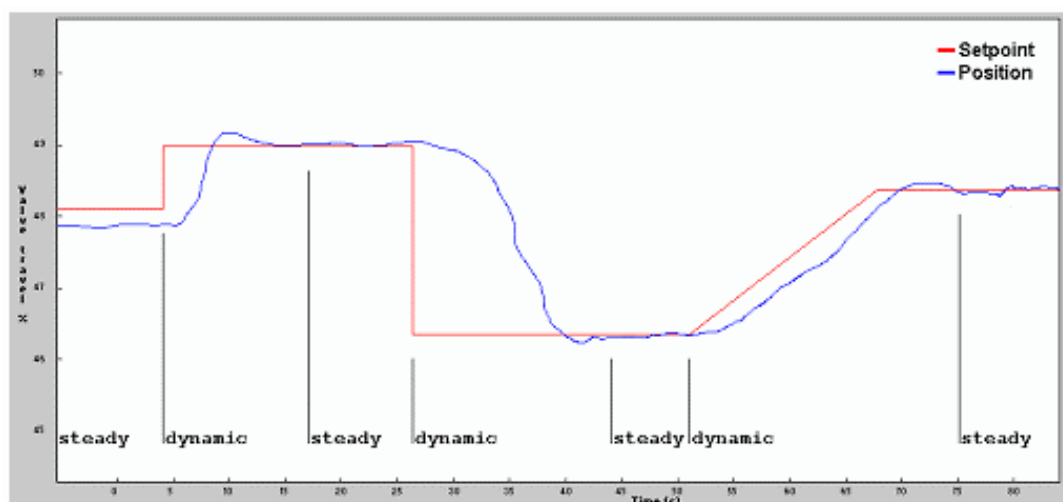


Figure 22. This graph illustrates steady states and dynamic states.

3.3.3.1.4 Dynamic State Deviation

Dynamic State Deviation can be used to estimate valve dynamics such as response times. It is updated whenever the setpoint changes and the valve is expected to move accordingly. Updating continues throughout the valve movement and is switched back to **Steady State** when both setpoint and valve position have reached a steady state.

Figure 22 illustrates this concept. Dynamic State Deviation trend is updated during the periods marked **dynamic**.

3.3.3.1.5 Stiction

Stiction, Stable State Load, and Load for Opening are the three pneumatic load measurements. You can use the Stiction value to estimate internal frictions in the control valve package:

- **Increased** stiction suggests an increase in internal friction, which can cause accuracy problems and ultimately prevent the valve from moving.
- **Decreased** stiction suggests a decrease in internal friction. This may indicate problems such as extensive wear or valve shaft break.

Whenever the valve moves, required pneumatic pressure in the actuator is registered. The stiction value can be calculated when measurements in both upscale and downscale directions have been registered.

3.3.3.1.6 Stable State Load

This trend shows Stable State Load measurement, which is especially significant for single-acting actuators since you can use it estimate the actuator spring force and spring state. The trend is based on the pneumatic pressure measurement that is carried out whenever the valve is in a stable state.

If the spring is broken, Stable State Load decreases noticeably.

3.3.3.1.7 Load for Opening

You can use Load for Opening to estimate the following:

- Seat wear, especially in butterfly valves
- Medium crystallization in e.g. ball valves

The Load for Opening trend is updated whenever the valve is opened from a fully closed position. Like stiction, this trend is based on the pneumatics measurement.

3.3.3.1.8 Spool Valve Position

This trend shows Spool Valve Position, which is measured as a percentage of the movement range. Spool Valve Position is typically in the middle of the range, but changes in the trend may suggest actuator (pneumatic) leak, especially with single-acting actuators.

3.3.3.1.9 Supply Pressure

You can use Supply Pressure trend as follows:

- To analyze possible problems with supply pressure

- To monitor pressure values that exceed device specifications

3.3.3.1.10 Temperature

Temperature trend shows the device temperature on the Printed Circuit Board (PCB) temperature. You can use measurement to monitor temperature values exceeding device specifications.

3.3.3.2 Histograms

3.3.3.2.1 Travel

Use the Travel Histogram trend to determine valve operation points. You can also use this information to verify valve sizing. A sample valve travel histogram is shown in figure 23.

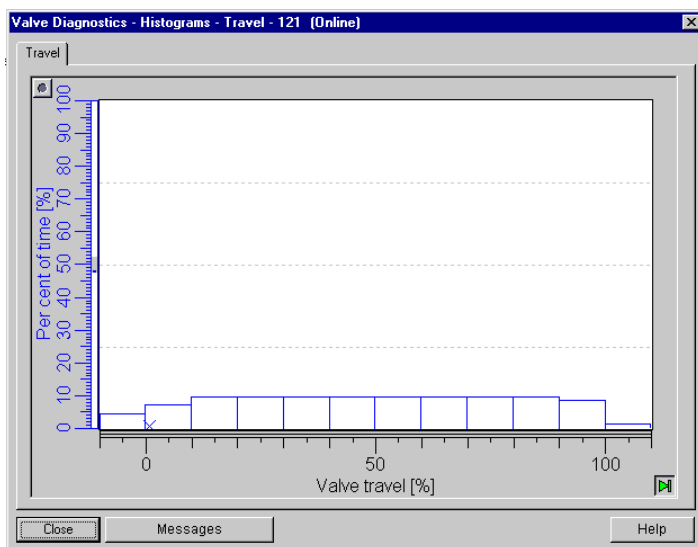


Figure 23. Valve travel histogram.

The last bar on the left (-10% - 0%) represents fully closed position. The last bar on the right (100 – 110%) represents fully open position.

3.3.3.2.2 Setpoint speed

Setpoint speed histogram shows the speed distribution of the setpoint from the control system.

3.3.3.2.3 Valve speed upscale

Valve speed histogram shows the speed distribution of the valve position upscale movements.

3.3.3.2.4 Valve speed downscale

Valve speed histogram shows the speed distribution of the valve position downscale movements.

3.3.3.3 Travel counters

Counters are basic tools for determining valve operation level.

- **Valve travel:** This counter increases by 1 whenever the valve has travelled one full stroke, or 100% of valve movement.
- **Valve reversals:** This counter increased by 1 whenever the direction of valve movement changes.
- **Actuator travel:** This counter increases by 1 whenever the valve has travelled one full stroke, or 100% of valve movement.
- **Actuator reversals:** This counter increased by 1 whenever the direction of valve movement changes.
- **Setpoint travel:** This counter increases by 1 whenever the cumulative setpoint changes.
- **Setpoint reversals:** This counter increases by 1 when the direction of the setpoint changes.
- **Spool valve travel:** This counter increases by 1 whenever the spool has travelled one full stroke, or 100% of spool movement.
- **Spool valve reversals:** This counter increases by 1 whenever the direction of spool changes.

3.3.3.4 On-line measurements

The on-line measurements window is presented in figure 24.

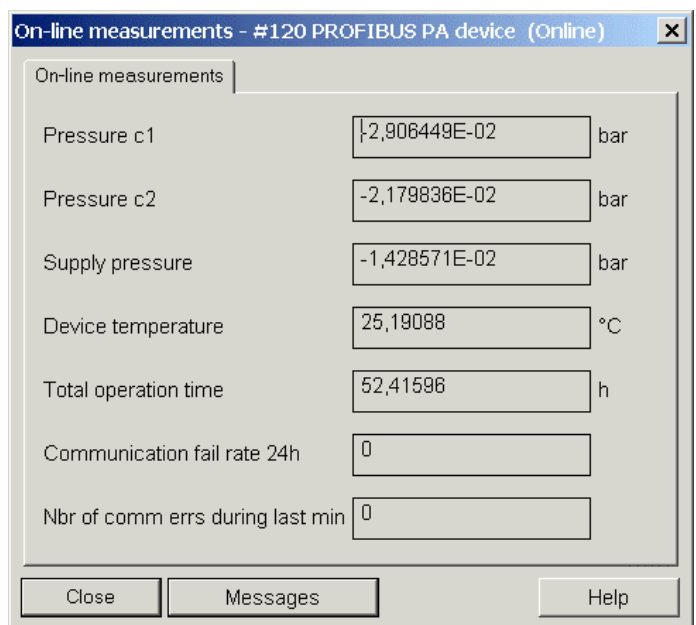


Figure 24. On-line measurements.

Pressure C1

Pressure measurement from C1 pneumatic connector.

Pressure C2

Pressure measurement from C2 pneumatic connector.

Supply pressure

Supply pressure measurement.

Device temperature

Device temperature measurement.

Total operation time

Device total operation time in hours.

Communication fail rate 24h avg

This parameter monitors the fieldbus communication failure rate in per cent. The value is a moving average of last 24 hours.

In ideal circumstances the value should remain zero. The bigger the value, the worse the fieldbus signal is.

The decreasing of the fieldbus signal quality may result from bad segment design (trunk and spur lengths, termination, shielding, grounding), loose connections or electro-magnetic disturbances (EMC).

Nbr of comm errs during last min

This parameter indicates the number of detected fieldbus communication errors during last one minute. The value of this parameter resets to zero every 1 min. Note that this parameter is available since software revision 1.30.

3.3.4 Event Log

ND9000P stores 8000 latest events and associated time stamps to the device memory.

The event log selector page is presented in figure 25 and sample event page is presented in figure 26.

Total operation time

Device total operation time in hours, current value. As an event occurs, this time is used as a time stamp.

Event log selector

This parameter is used to select the events that are displayed in the pages **Events1** and **Events2**. Options are;

- Show 25 latest events
- Show next 25 events
- Show previous 25 events

Event log status

Displays the status of the trend selection procedure.

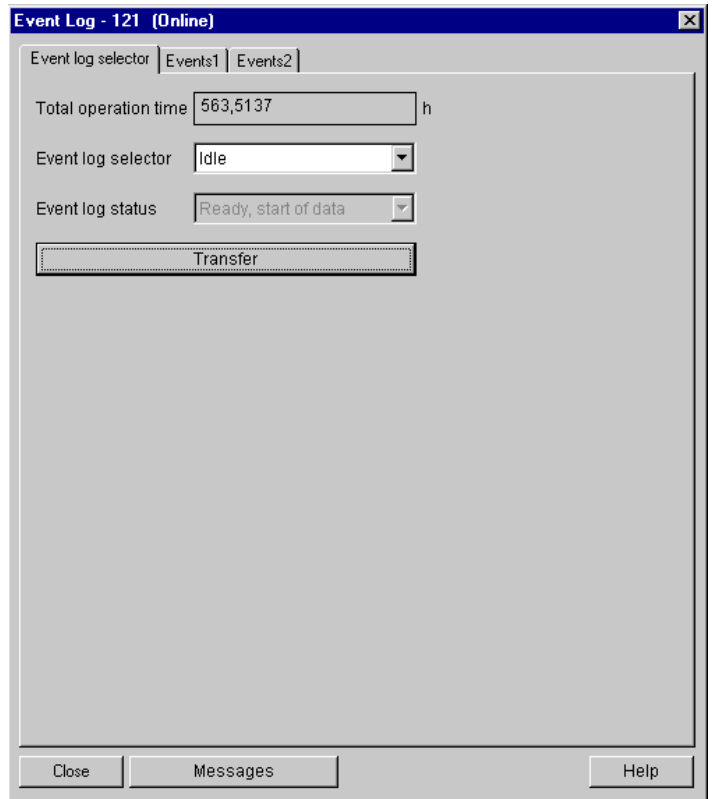


Figure 25. Event log selector.

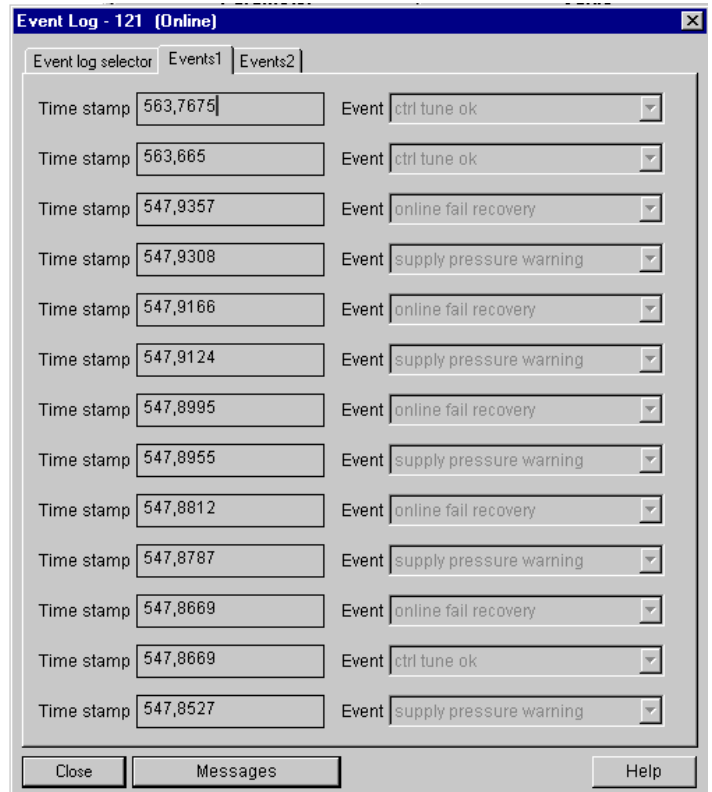


Figure 26. Page Events1.

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