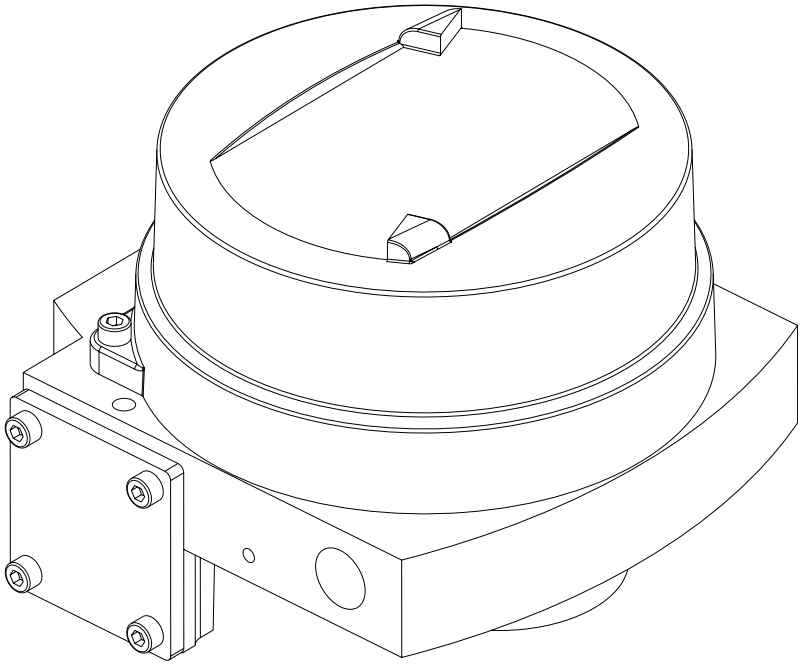
neles

INTELLIGENT VALVE CONTROLLER ND9300P

Rev. 2.2

Installation, Maintenance and Operating Instructions



metso
Expect results

7 ND93P 70 en • 12/2009

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READ THESE INSTRUCTIONS FIRST!
These instructions provide information about the safe handling and operation of the intelligent valve controller.
If you require additional assistance, please contact the manufacturer or manufacturer's representative.
Addresses and phone numbers are printed on the back cover.
SAVE THESE INSTRUCTIONS!

1 ND9000 PRODUCT FAMILY SUMMARY

1.1 Key features

- ❑ Benchmark control performance on rotary and linear valves
- ❑ Reliable and robust design
- ❑ Ease of use
- ❑ Language selection: English, German and French
- ❑ Local / remote operation
- ❑ Expandable architecture
- ❑ Advanced device diagnostics including
  - ❑ Self-diagnostics
  - ❑ Online diagnostics
  - ❑ Performance diagnostics
  - ❑ Communication diagnostics
  - ❑ Extended off-line tests
  - ❑ Intelligent Valve Diamond

1.1.1 Options

- ❑ Interchangeable communication options:
  - ❑ Profibus PA
  - ❑ FOUNDATION Fieldbus
  - ❑ HART
- ❑ Exhaust adapter

1.1.2 Total cost of ownership

- ❑ Low energy and air consumption
- ❑ Future proof design allows further options at a reduced cost
- ❑ Optimised spares program. Reduced number of spares
- ❑ Retro-fit to existing installations (Neles or 3rd party)

1.1.3 Minimised process variability

- ❑ Linearisation of the valve flow characteristics
- ❑ Excellent dynamic and static control performance
- ❑ High-speed of response
- ❑ Accurate internal measurements

1.1.4 Easy installation and configuration

- ❑ Same unit for linear and rotary valves, double and single-acting actuators
- ❑ Simple calibration and configuration
  - using Local User Interface
  - using Profibus configurator, such as FieldCare or Simatic PDM
- ❑ Flush mounting capability to avoid tubing and mounting parts
- ❑ Low power design enables installation to all common control systems

1.1.5 Open solution

Metso is committed to delivering products that freely interface with software and hardware from a variety of manufacturers; and the ND9000 is no exception. This open architecture allows the ND9000 to be integrated with other field devices to give an unprecedented level of controllability.

- ❑ FDT based multi-vendor support configuration
  ND9000 DTM download page:
  www.metso.cm/automation/nd9000

1.1.6 ND9000 in fieldbus networks

- ❑ Approved interoperability
  - ❑ Host interoperability ensured
  - ❑ FOUNDATION Fieldbus ITK version 4.51 certified
  - ❑ Profibus PA profile version 3.0 PNO certified
- ❑ Easy to upgrade; can be done by replacing the HART communication board to fieldbus communication board
- ❑ Excellent maintainability with firmware download-feature
- ❑ Advanced communication diagnostics
- ❑ Digital communication via the fieldbus includes not only the set point, but also the position feedback signal from the position sensor. No special supplementary modules for analog or digital position feedback are needed when using the fieldbus valve controller.
- ❑ Back up LAS functionality available in FOUNDATION Fieldbus enviroment
- ❑ Input selector and output splitter blocks available in FOUNDATION Fieldbus devices allowing advanced distributed control
- ❑ Multipurpose functionality
  - ❑ Standard function blocks enables the freedom to use ND9000 intelligent valve controller either in continuous or on-off control applications
  - ❑ Open and close information directly available via the fieldbus
  - ❑ Open and close detection is based on either position measurement (soft limit switch) or mechanical limit switch information
- ❑ ND9000 download page:
  www.metso.com/automation/nd9000

1.1.7 ND9000 mounting on actuators and valves

- ❑ Mounted on single and double acting actuators
- ❑ Both rotary and linear valves
- ❑ Flush mounting capability
- ❑ Ability to attach options to electronics and mechanics later
- ❑ Possibility to mount also on valves that are in process with 1-point calibration feature

1.1.8 Product reliability

- ❑ Designed to operate in harsh environmental conditions
  - ❑ Rugged modular design
  - ❑ Excellent temperature characteristics
  - ❑ Vibration and impact tolerant
  - ❑ IP66 enclosure
  - ❑ Protected against humidity
- ❑ Maintenance free operation
  - ❑ Resistant to dirty air
  - ❑ Wear resistant and sealed components
  - ❑ Contactless position measurement

1.1.9 Predictive maintenance

- ❑ Easy access to collected data with FieldCare software
  - ❑ Ingenious Valve Diamond to visualise control valve performance & diagnostics
  - ❑ Logical trend and histogram collection
  - ❑ Information collected on service conditions
  - ❑ Extensive set of off-line tests with accurate key figure calculations
  - ❑ Fast notifications using on-line alarms
  - ❑ Condition monitoring tool available
  - ❑ Real time monitoring of valve control parameters.

2 ND9300P INTELLIGENT VALVE CONTROLLER WITH PROFIBUS PA COMMUNICATION

2.1 General

This manual incorporates Installation, Maintenance and Operation Instructions for the Metso ND9300P intelligent valve controller. The ND9300P may be used with either cylinder or diaphragm type pneumatic actuators for rotary or linear valves.

NOTE:
The selection and use of the valve controller in a specific application requires close consideration of detailed aspects. Due to the nature of the product, this manual cannot cover all the likely situations that may occur when installing, using or servicing the valve controller.
If you are uncertain about the use of the controller or its suitability for your intended use, please contact Metso's Automation business for more information.

2.2 Technical description

The ND9300P is a fieldbus powered microcontroller-based intelligent valve controller. The ND9300P configuration can be done either using local push buttons or profibus configurator.

The powerful 32-bit microcontroller controls the valve position. The measurements include:

- ❑ Input signal
- ❑ Valve position with contactless sensor
- ❑ Actuator pressures, 2 independent measurements
- ❑ Supply pressure
- ❑ Spool valve position
- ❑ Device temperature

Advanced self-diagnostics guarantees that all measurements operate correctly. Failure of one measurement does not cause the valve to fail if the input signal and position measurements are operating correctly. After connections of electric signal and pneumatic supply the micro controller (µC) reads the input signal, position sensor (α), pressure sensors (Ps, P1, P2) and spool position sensor (SPS). A difference between input signal and position sensor (α) measurement is detected by the control algorithm inside the µC. The µC calculates a new value for prestage (PR) coil current based on the information from the input signal and from the sensors. Changed current to the PR changes the pilot pressure to the spool valve. Reduced pilot pressure moves the spool and the actuator pressures change accordingly. The spool opens the flow to the driving side of the double diaphragm actuator and opens the flow out from the other side of the actuator. The increasing pressure will move the diaphragm piston. The actuator and feedback shaft rotate clockwise. The position sensor (α) measures the rotation for the µC. The µC using control algorithm modulates the PR-current from the steady state value until a new position of the actuator according to the input signal is reached.

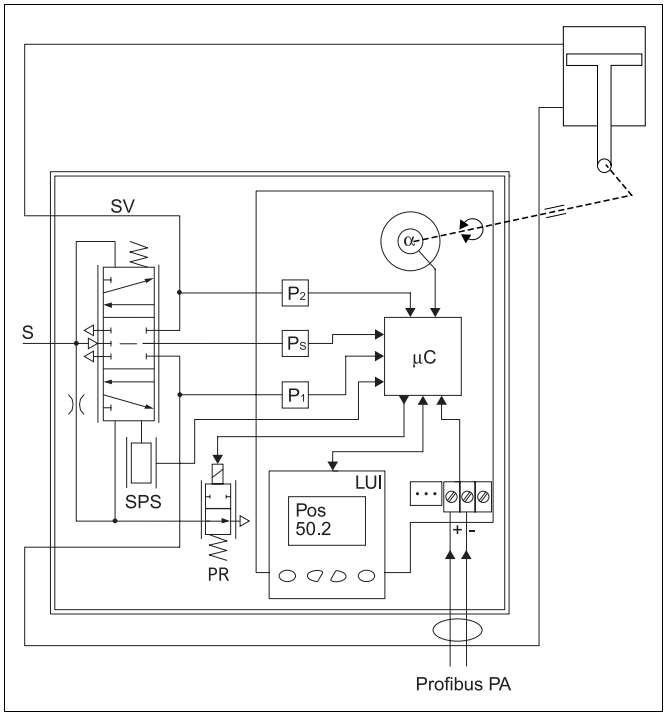


Fig. 1 The principle of operation

2.3 Markings

The valve controller is equipped with an identification plate sticker (Fig. 2 and 3).

Fig. 2 Example of the identification plate, ND9303PX1

Fig. 3 Example of the identification plate, ND9303PX3

Identification plate markings from top to bottom include:

- ❑ Type designation of the valve controller
- ❑ Revision number
- ❑ Enclosure class
- ❑ Input signal (voltage range)
- ❑ Input resistance
- ❑ Maximum supply voltage
- ❑ Operational temperature
- ❑ Supply pressure range
- ❑ Contact details of the manufacturer
- ❑ CE mark
- ❑ Manufacturing serial number TTYYWWNNNN*)

*) Manufacturing serial number explained:
TT = device and factory sign
YY = year of manufacturing
WW = week of manufacturing
NNNN = consecutive number

Example: PH09011234 = controller, year 2009, week 1, consecutive number 1234.

2.4 Technical specifications

ND9300P INTELLIGENT VALVE CONTROLLER

General

Bus powered, no external power supply required.
Suitable for rotary and sliding-stem valves.
Actuator connections in accordance with VDI/VDE 3845 and IEC 60534-6 standards.

Flush mounting on NelesCV™ control valves.

Action: Double or single acting

Travel range: Linear; 10–120 mm with standard IEC parts. Larger strokes possible with suitable kits
Rotary: 45–95°.
Measurement range 110° with freely rotating feedback shaft.

Environmental influence

Standard temperature range:
-40° – +85 °C / -40° – +185 °F

Influence of temperature on valve position:
< 0.5 % / 10 °K

Influence of vibration on valve position:
< 1 % under 2g 5–150 Hz,
1g 150–300 Hz, 0.5g 300–2000 Hz

Enclosure

Material: Full stainless steel enclosure

Protection class: IP66, NEMA 4X

Pneumatic ports: 1/4 NPT

Electrical connection: max. 2.5 mm^2

Cable gland thread: M20 x 1.5 (E1)

Weight: 8.6 kg / 19.0 lb

Pneumatics

Supply pressure: 1.4–8 bar / 20–115 psi

Effect of supply pressure on valve position:
< 0.1 % at 10 % difference in inlet pressure

Air quality: According to ISO 8573-1:2001
Solid particles: Class 5
(3–5 µm filtration is recommended)
Humidity: Class 1
(dew point 10 °C/50 °F below minimum temperature is recommended)
Oil class: 3 (or <1 ppm))

Capacity with 4 bar / 60 psi supply:
5.5 Nm^3/h / 3.3 scfm (spool valve 2)
12 Nm^3/h / 7.1 scfm (spool valve 3)
38 Nm^3/h / 22.4 scfm (spool valve 6)

Consumption with 4 bar / 60 psi supply in steady state position:
< 0.6 Nm^3/h / 0.35 scfm (spool valves 2 & 3)
< 1.0 Nm^3/h / 0.6 scfm (spool valve 6)

Electronics

Power supply: taken from bus

Bus voltage: 9 to 32 V DC, reverse polarity protection

Max basic current: 17.2 mA

Fault current (FDE):3.9 mA

Ex ia IIC T6: Ui ≤ 24 V
Ii ≤ 380 mA
Pi ≤ 5.32 W
Ci < 5 nF
Li < 10 µH

Ex nL IIC: Ui ≤ 32 V
Ii ≤ 380 mA
Pi ≤ 5.32 W
Ci < 5 nF
Li < 10 µH

Ex nA II: Ui ≤ 24 V
Ii ≤ 380 mA
Pi ≤ 5.32 W
Ci < 5 nF
Li < 10 µH

(ATEX approval is valid under these conditions)

Performance with moderate constant-load, actuators EC05-EC10

Values at 20 °C / 68 °F and without any additional instruments, such as boosters or quick exhaust valves etc.

Dead band acc. to IEC 61514:
≤ 0.1 %

Hysteresis acc. to IEC 61514:
< 0.5 %

Local user interface functions

- ❑ Local control of the valve
- ❑ Monitoring of valve position, input signal, temperature, supply and actuator pressure difference
- ❑ Guided start-up function
- ❑ LUI may be locked remotely to prevent unauthorised access
- ❑ Calibration: Automatic / Manual
- ❑ 1-point calibration
- ❑ Limit switch state monitoring
- ❑ Control configuration: aggressive, fast, optimum, stable, maximum stability
- ❑ Mode selection: Automatic/Manual
- ❑ Rotation: valve rotation clockwise or counterclockwise to close
- ❑ Dead angle
- ❑ Low cut-off, cut-off safety range (default 2 %)
- ❑ Positioner fail action, open/close
- ❑ Actuator type, double/single acting
- ❑ Valve type, rotary/linear IEC/nelesCV Globe/FLI
- ❑ Language selection: English, German and French

Approvals

Intrinsically safe and non incendive

ATEX

IEC 60079-0 (2007),EN 60079-11(2007), EN 60079-26 (2007), EN 60079-27 (2006), EN 61241-0 (2006), EN 61241-1 (2004)
II 1G Ex ia IIC T4/T5/T6 Ga
II 1D Ex tD A20 T90 °C
or
II 2 G Ex ia IIC T4/T5/T6 Gb
II 2 D Ex tD A21 T90 °C

IEC 60079-0 (2007), EN 60079-15 (2005), EN 60079-27 (2006), EN 61241-0 (2006), EN 61241-1 (2004)
II 3 G Ex nA IIC T4/T5/T6
II 3 D Ex tD A22 T90 °C
or
II 3 G Ex nL IIC T4/T5/T6
II 3 D Ex tD A22 T90 °C

CSA CAN/CSA-C22.2-0,-142, -157;
CAN/CSA-E60079-0,-11, -15
IS Class I, Div. 1, Groups A, B, C, D T4...T6
IS Class I, Zone 0, Ex ia IIC T4...T6
NI Class I, Div. 2, Groups A, B, C, D T4...T6
Pending

FM FM Class 3600, 3610, 3611, 3810:
IS Class I, Div. 1, Groups A, B, C, D T4...T6
IS Class I, Zone 0, AEx ia IIC T4...T6
NI Class I, Div. 2, Groups A, B, C, D T4...T6
NI Class I, Zone 2, Ex nA II T4...T6
Pending

Flameproof and explosion proof

ATEX II 2 G Ex d IIC T4...T6
(EN 60079-0:2006, EN 60079-1:2004)

II 2 D Ex tD A21 IP66 T100 °C
(EN 61241-0:2006, EN 61241-1:2004)

Electromagnetic protection

Electromagnetic compatibility
Emission acc. to EN 61000-6-4 (2001)
and FCC 47 CFR PART 15,
SUBPART B, CLASS B (1994)
Immunity acc. to EN 61000-6-2 (2001)

CE marking

89/336/EEC
Electromagnetic compatibility

94/9/EC
ATEX

2.5 Recycling and disposal

Most valve controller parts can be recycled if sorted according to material.

Most parts have material marking. A material list is supplied with the valve controller. In addition, separate recycling and disposal instructions are available from the manufacturer.

A valve controller may also be returned to the manufacturer for recycling and disposal. There will be a charge for this.

2.6 Safety precautions

CAUTION:
Do not exceed the permitted values!
Exceeding the permitted values marked on the valve controller may cause damage to the controller and to equipment attached to the controller and could lead to uncontrolled pressure release in the worst case. Damage to the equipment and personal injury may result.

CAUTION:
Do not remove or dismantle a pressurized controller!
Removing or dismantling a pressurized prestage or spool valve of an ND9300P leads to uncontrolled pressure release. Always shut off the supply air and release the pressure from the pipelines and equipment before removing or dismantling the controller. Otherwise personal injury and damage to equipment may result.

WARNING:
During automatic or manual calibration and tuning the valve operates between open and closed positions. Make sure that the operation does not endanger people or processes!

WARNING:
Do not operate the device with electronics cover (39) removed!
Electromagnetic immunity is reduced, valve may stroke. Explosion protection may be impaired.

Ex d WARNING:
Do not open the device when energized!
Explosion protection is lost.
Electromagnetic immunity is reduced, valve may stroke.

Ex d and Ex n WARNING:
Use a cable gland with suitable Ex d or Ex n certification.
For ambient temperature over 70 °C / 158 °F use a heat resistant cable and cable gland suitable for at least 90 °C / 194 °F.

Intrinsic Safety (Ex i) WARNING:
Ensure that the complete installation and wiring is intrinsically safe before operating the device!
The equipment must be connected via a certified Zener barrier placed outside the hazardous area.

ATEX WARNING:
Electrostatic charge hazard!
The pointer and display windows are non-conductive. Clean with a damp cloth only!

Spark hazard!
Protect the aluminium housing from impacts and friction!

ATEX WARNING:
For use in the presence of combustible dust.
Ignition protection relies on the enclosure. Protect the cover of the valve controller from impacts. When temperature is higher than 70 °C the temperature rating of the cable shall be higher than the temperature.

NOTE:
Avoid earthing a welding machine in close proximity to an ND9300P valve controller.
Damage to the equipment may result.

Ex d NOTE:
Follow the installation guidelines in EC-EN 60079-10 when mounting the equipment.

3 TRANSPORTATION, RECEPTION AND STORAGE

The valve controller is a sophisticated instrument, handle it with care.

- ❑ Check the controller for any damage that may have occurred during transportation.
- ❑ Store the uninstalled controller preferably indoors, keep it away from rain and dust.
- ❑ Do not unpack the device until installing it.
- ❑ Do not drop or knock the controller.
- ❑ Keep the flow ports and cable glands plugged until installing.
- ❑ Follow instructions elsewhere in this manual.

4 MOUNTING

4.1 General

NOTE:
The enclosure of ND9300P intelligent valve controller meets the IP66 protection class according to EN 60529 in any position when the cable entry is plugged according to IP66.
Based on good mounting practice, the recommended mounting position is electrical connections placed downwards. This recommendation is shown in our mounting position coding for control valves.
If these requirements are not fulfilled, and the cable gland is leaking and the leakage is damaging valve controller or other electrical instrumentation, our warranty is not valid.

If the ND9300P is supplied with valve and actuator, the tubes are mounted and the ND9300P adjusted in accordance with the customer's specifications. If the controller is ordered separately, the mounting parts for the assembly must be ordered at the same time.

Sample order: (B1CU13)-Z-ND9306HN

The controller is equipped with the Metso flush mounting face, the old Neles mounting face and for connection according to VDI/VDE 3845.

Shaft coupling alternatives for the controller for Metso actuators are shown in Fig. 5.

For mounting parts for Metso actuators, see 11.2 - 11.5.

4.2 Mounting on Metso actuators with VDI/VDE mounting face

See figures in Section 11.2 -11.4.

- ❑ Mount the H-shaped coupling (47) to the shaft. Apply the thread-locking compound to the screw (48) and tighten firmly.
- ❑ Remove the protective plastic plugs from pneumatic connections C2, S and C1. Leave the metal plugs (54) in the unused connections at the bottom of the controller.
- ❑ **BJ and other single acting actuators:** install a metal plug (53) with sealant to the C1 connection.
- ❑ Set the direction arrow of the actuator in the direction of the valve closure member and attach the ear (2) to the indicator cover in the position shown in Section 11.2. Secure the screw of the ear using e.g. Loctite and tighten firmly.
- ❑ Attach the bracket (1) to the ND9300P.
- ❑ Attach the bracket (1) to the actuator. The shaft coupling of the ND9300P must fit into the ear (2) so that the pointer is located in the position shown in Fig. 4.

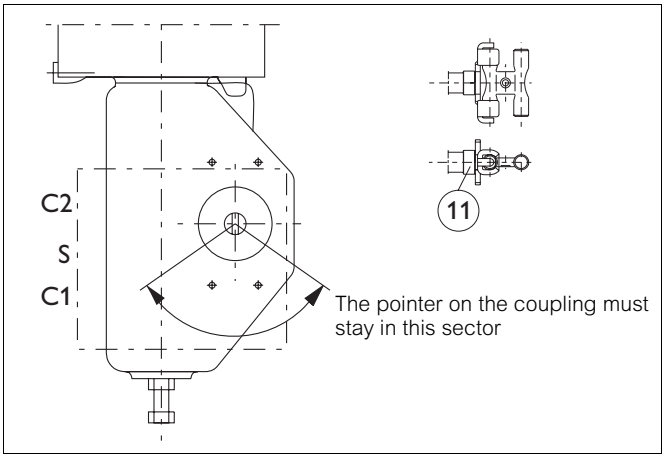


Fig. 4 Mounting on Metso actuator with VDI/VDE mounting face

4.3 Mounting on linear actuator with IEC 60534 mounting face

See figure in Section 11.5

- ❑ Attach the feedback arm with spacer to the valve controller shaft. Note the position of the pointer on the shaft as in 11.5. Apply thread locking compound to the screws and tighten firmly. Attach the spring to the feedback arm as shown in Section 11.5.
- ❑ Mount the valve controller mounting bracket loosely to the yoke of the actuator.
- ❑ Remove the protective plastic plugs from pneumatic connections C2, S and C1. Leave the metal plugs (54) in the unused connections at the bottom of the controller. Single acting actuators: install a metal plug (53) with sealant to the C1 connection.
- ❑ Mount the valve controller loosely to the mounting bracket guiding the pin on the actuator stem to the slot of the feedback arm.

- ❑ Align the bracket and the valve controller with the actuator stem and adjust their position so that the feedback arm is approximately at a 90° angle to the actuator stem (in the mid-stroke position).Tighten the valve controller mounting bracket screws.
- ❑ Adjust the distance of the valve controller to the pin on the actuator stem so that the pin stays in the lever slot at full stroke. Ensure also that the maximum angle of the lever does not exceed 45° in either direction. Maximum allowed travel of the lever is shown in Section 11.5. Best control performance is achieved when the feedback lever utilises the maximum allowed angle (±45° from horizontal position). The whole range should be at least 45°.
- ❑ Make sure that the valve controller is in right angle and tighten all the mounting bolts.
- ❑ Ensure that the valve controller complies with previous steps. Check that the actuator pin does not touch the valve controller case throughout the entire stroke of the actuator. If the actuator pin is too long it may be cut to size.
- ❑ Apply grease (Molykote or equivalent) to the contact surfaces of the actuator pin and the feedback arm to reduce wear.

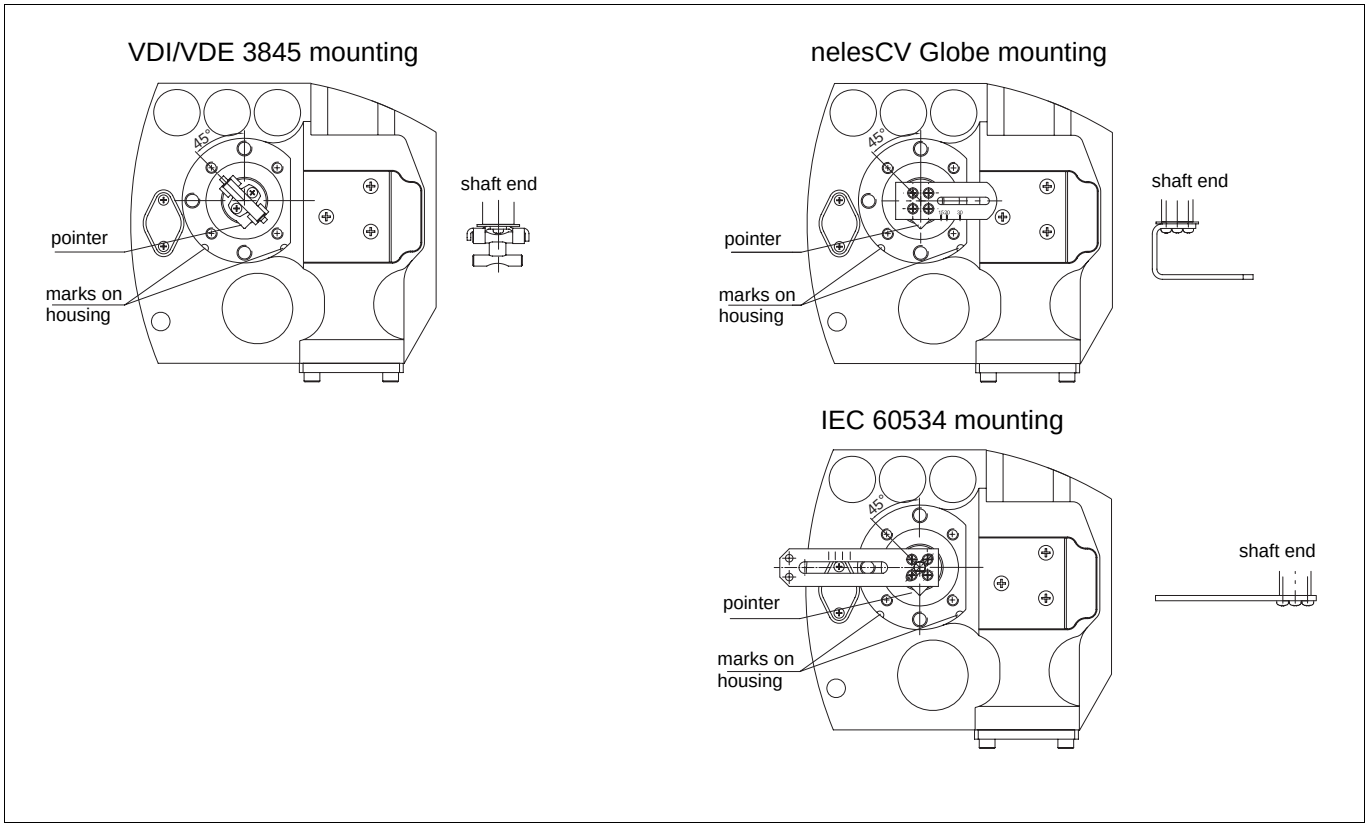


Fig. 5 Shaft coupling alternatives

4.4 Piping

CAUTION:
Do not exceed the permitted supply pressure of the ND9300P!

Table 2 provides the recommended tube sizes in accordance with actuator sizes. Tube sizes are the minimum values allowed. Operating times may be tested by the FieldCare software.

Connect the air supply to S (1/4 NPT).

Connect C1 and C2 (1/4 NPT) to the actuator, see Fig. 6.

Liquid sealants, such as Loctite 577 are recommended for the pipe threads.

NOTE:
A valve controller mounted on a spring actuator must be connected only as single-acting. See Fig. 6.

NOTE:
An excess of sealant may result in faulty operation of the controller.
Sealing tape is not recommended.
Ensure that the air piping is clean.

The air supply must be clean, dry and oil-free instrument air, see Section 2.4.

Table 1 Spring rates

Actuator type	Spring rate (bar/psi)
B1JK	3 / 43
B1J	4.2 / 61
B1JV	5.5 / 80
QPB	3 / 43
QPC	4.3 / 62
QPD	5.6 / 81
EJK	3 / 43
EJ	4 / 57
EJV	5 / 72
Adjust regulator pressure to a level that is max 1 bar (14.5 psi) + spring rate.	

Table 2 Piping

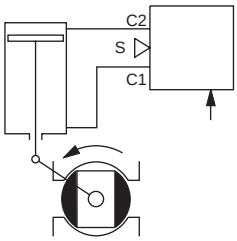
Actuator			Actuator piping				Spool valve
EC	**Stroke vol. dm^3 / in^3**	**G**	**6**	**10**	**1/4**	**3/8**	
05	0.09 / 5	1/4	x		x		2
07	0.2 / 12	1/4	x		x		2
10	0.5 / 31	1/4	x		x		3
12	1.2 / 73	1/4	x		x		3
14	3.0 / 183	1/4		x		x	6
16	7.7 / 470	3/8		x		x	6
25	20.5 / 1250	3/8		x		x	6
EJ	**Stroke vol. dm^3 / in^3**	**G**	**6**	**10**	**1/4**	**3/8**	**Spool valve**
05	0.18 / 11	1/4	x		x		2
07	0.4 / 24	1/4	x		x		2, 3*
10	1 / 61	1/4	x		x		3
12	2.4 / 145	1/4		x		x	3
14	6 / 366	1/4		x		x	6
16	15 / 915	3/8		x		x	6
25	41 / 2500	3/8		x		x	6
B1C	**Stroke vol. dm^3 / in^3**	**NPT**	**6**	**10**	**1/4**	**3/8**	**Spool valve**
6	0.3 / 18	1/4	x		x		2, 3*
9	0.6 / 37	1/4	x		x		3
11	1.1 / 67	3/8	(x)	x	(x)	x	3
13	2.3 / 140	3/8		x		x	3
17	4.3 / 262	1/2		x		x	6
20	5.4 / 330	1/2		x		x	6
25	10.5 / 610	1/2		x		x	6
32	21 / 1282	3/4		x		x	6
40	43 / 2624	3/4		x		x	6
50	84 / 5126	1		x		x	6
502	195 / 11900	1		x		x	6
B1J B1JA	**Stroke vol. dm^3 / in^3**	**NPT**	**6**	**10**	**1/4**	**3/8**	**Spool valve**
8	0.9 / 55	3/8	(x)	x	(x)	x	3
10	1.8 / 110	3/8		x		x	3
12	3.6 / 220	1/2		x		x	6
16	6.7 / 409	1/2		x		x	6
20	13 / 793	3/4		x		x	6
25	27 / 1648	3/4		x		x	6
32	53 / 3234	1		x		x	6
322	106 / 6468	1		x		x	6
QP	**Stroke vol. dm^3 / in^3**	**NPT**	**6**	**10**	**1/4**	**3/8**	**Spool valve**
1	0.62 / 37	3/8	(x)	x	(x)	x	2, 3*
2	1.08 / 66	3/8	(x)	x	(x)	x	3
3	2.18 / 133	3/8		x		x	3
4	4.34 / 265	3/8		x		x	6
5	8.7 / 531	3/8		x		x	6
6	17.5 / 1068	3/4		x		x	6

Air supply piping 10 mm or 3/8" for all actuators.

Pipe sizes are nominal, i.e. approximately outer diameter. Inner diameter is typically 2 mm smaller.
x = Standard pipe size used in Neles control valves.
(x) = Minimum pipe size (if smaller than standard).
*) Spool size 2 is preferred for accurate control and standard for Neles control valves.
Spool size 3 can be used if fast full stroke times are required.

DOUBLE-ACTING ACTUATOR

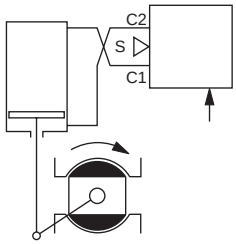
1. Self closing



Default setting:
ROT = cC (close valve to clockwise)
ATYP = 2-A
PFA = CLO
A0, CUTL and VTYP according to valve type

DOUBLE-ACTING ACTUATOR, REVERSED PIPING

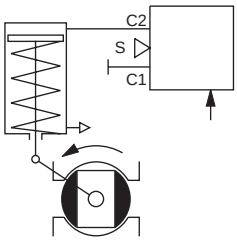
2. Self opening



Default setting:
ROT = cC (close valve to clockwise)
ATYP = 2-A
PFA = OPE
A0, CUTL and VTYP according to valve type

SINGLE-ACTING ACTUATOR, SPRING TO CLOSE

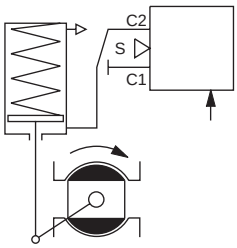
3. Self closing



Default setting:
ROT = cC (close valve to clockwise)
ATYP = 1-A
PFA = CLO (must be in the spring direction)
A0, CUTL and VTYP according to valve type

SINGLE-ACTING ACTUATOR, SPRING TO OPEN

4. Self opening



Default setting:
ROT = cC (close valve to clockwise)
ATYP = 1-A
PFA = OPE (must be in the spring direction)
A0, CUTL and VTYP according to valve type

Fig. 6 Operation directions and air connections

4.5 Electrical connections

The ND9300P is powered by Profibus PA (IEC 61158-2). The same bus cable is used also for the fieldbus communication.

The bus cable is led through a M20 x 1.5 (E1)/1/2 NPT (E2) cable gland. Connect the conductors to the terminal strip as shown in Fig. 7.

Reverse polarity protection permits connection of the bus cables in any order.

The cable shield can be grounded by connecting the shield to the earth connection screw. The shield can be left unconnected by using the empty terminal.

Please note following before mounting the cover of the valve controller:

- ❑ Attach the LUI (223) cabling to the sticker on the reverse side of the LUI.
  Check that the cabling does not get squeezed by the electronics cover (39) or the device cover (100).
- ❑ Check using a feeler gauge that the clearance between the position indicator (109) and the electronics cover is 1 mm.

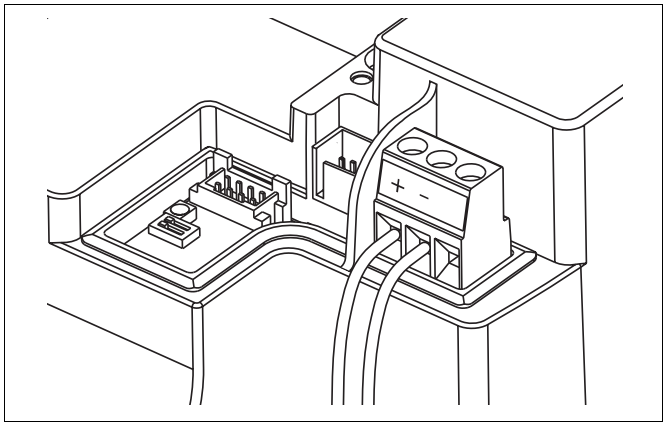


Fig. 7 Terminals

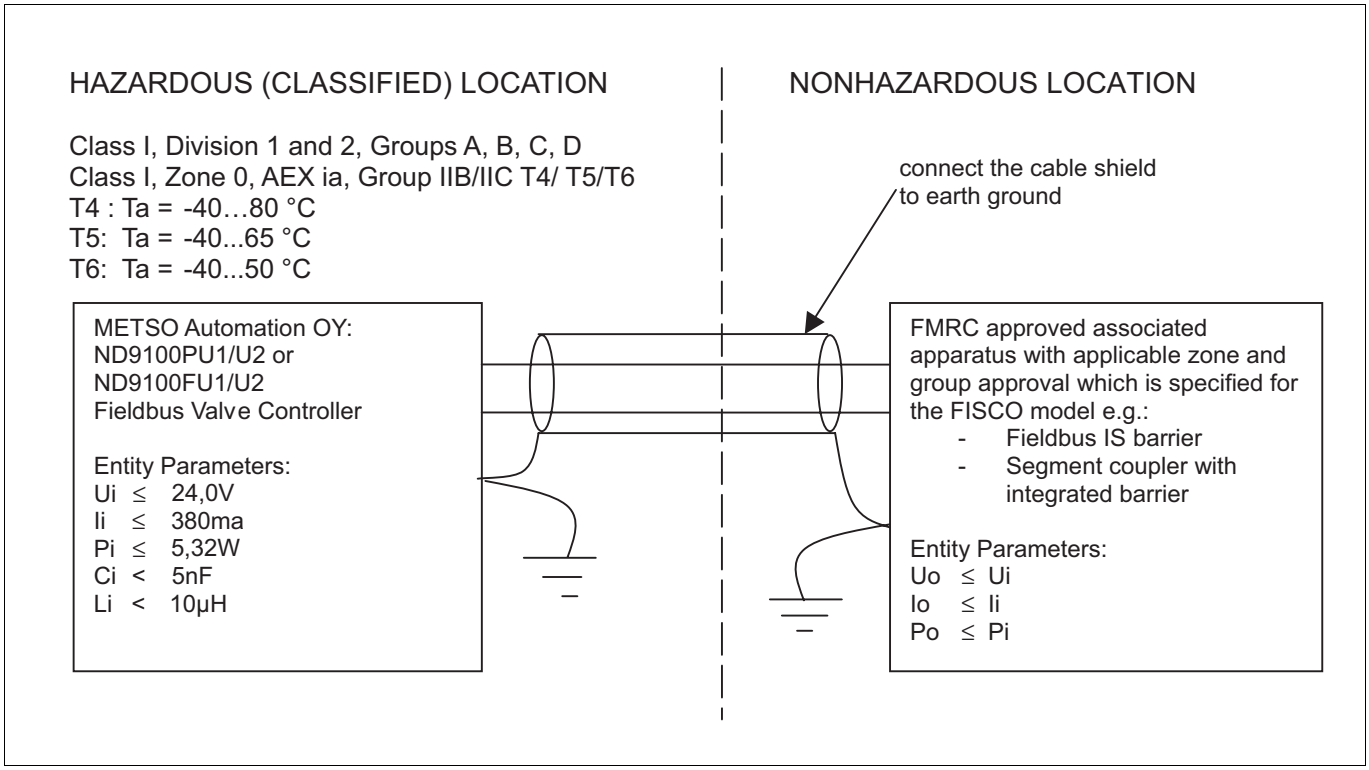


Fig. 8 Control wiring

5 LOCAL USER INTERFACE (LUI)

The local user interface may be used to monitor the device behaviour as well as configuring and commissioning the controller during installation and normal operation. The local user interface consists of 2 row LCD and 4 button keypad interface. There are also custom graphical characters for special conditions.

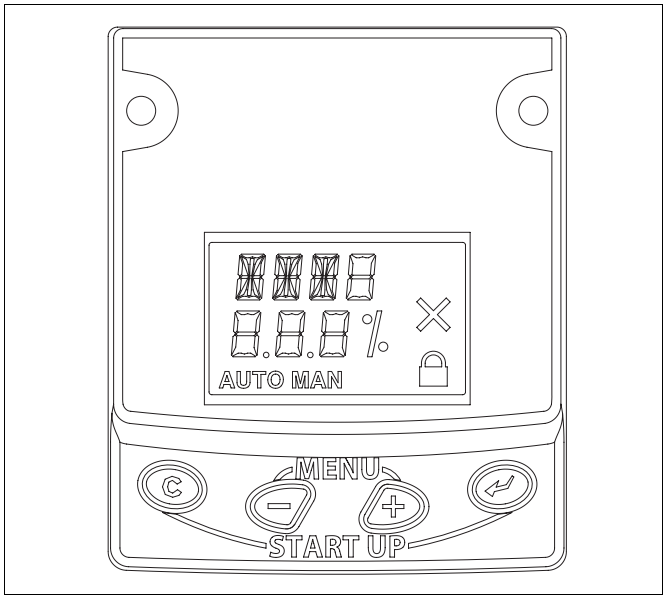


Fig. 9 Local user interface (LUI)

5.1 Measurement monitoring

When the device is powered, it enters the measurement monitoring view. The following measurements may be viewed from the display. The Table 3 identifies the default unit and also optional unit of the measurement.

Table 3 Default / optional units of measurements

Measurement	Default unit	Optional unit
valve position	percentage of full scale	angle, where 0 % refers to 0 (angle)
target position	percentage of full scale	none
setpoint	percentage of full scale	
actuator pressure difference	bar	psi
supply pressure	bar	psi
device temperature	° Celsius	° Fahrenheit

If the unit selection is altered from the FieldCare software to US units, the pressure default unit will automatically be changed to psi and temperature unit to Fahrenheit.

The active unit may be changed by pressing the ↵ key constantly. The display shows the current unit selection on the top row of the display. You may change the selection by pressing ⊕ or ⊖ while keeping the ↵ key pressed down. When the buttons are released the current selection will be activated.

If the device has been idle for 1 hour, and there is no user activity on the local user interface, the measurements will start scrolling on the display. This enables the user to view all the measurements through the window of the main cover.

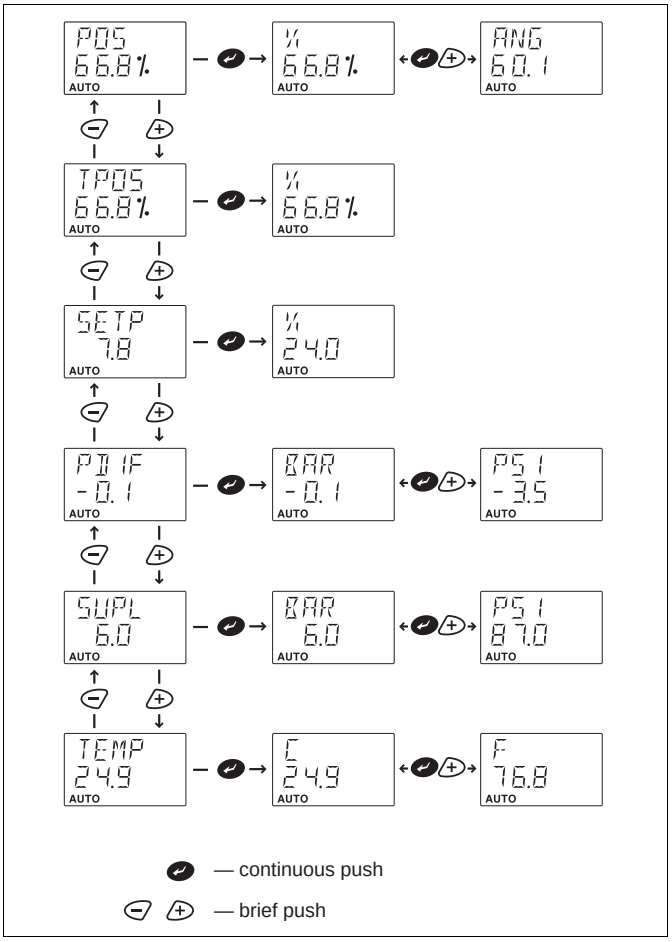


Fig. 10 Measurement unit change

5.2 Guided start-up

Guided startup offers a fast view of the most critical parameters of the ND9300P controller, actuator and valve configuration. After verifying the parameters the valve travel calibration is recommended. The guided start-up is entered by pressing the ⓒ and ↵ keys simultaneously.

The configuration parameters are listed in following order, see explanation from 5.5:

Valve type	VTYP
Actuator type	ATYP
Positioner fail action	PFA
Valve rotation direction	ROT
Valve dead angle	A0
PA address	ADR

If you modify any of the parameters you will also need to calibrate and tune the device. See 5.6 for detailed description.

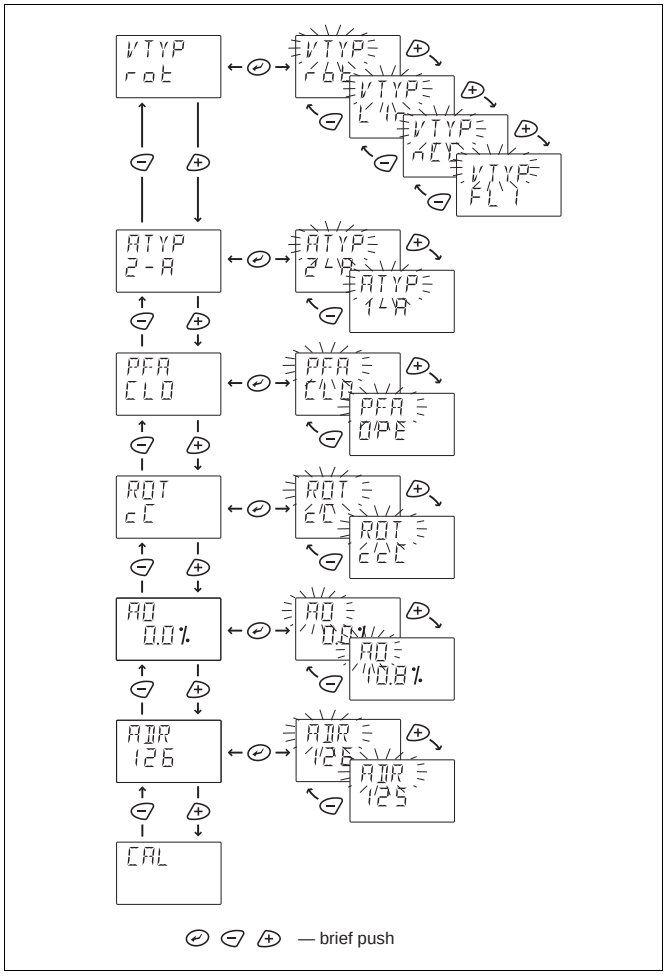


Fig. 11 Guided start-up

NOTE:
You may cancel any action by pressing the © button. Cancelling of operation returns user interface view one level up in menu hierarchy.

5.3 Configuration menu

The local user interface is organised in a menu structure. To enter the menus press ⊕ and ⊖ simultaneously in the measurement monitoring view panel. To move to the next or previous selection by pressing ⊕ or ⊖ accordingly.

5.4 Mode menu

If the user wants to change the valve operating mode, press the ↵ key at the MODE selection. The mode will start to flash and by pressing ⊕ or ⊖ you may alter the operation mode selection. User accepts the current selection by pressing the ↵ key.

There are two options for the operating mode.

5.4.1 AUTO

During the auto mode, the controller controls the valve position according to the incoming setpoint signal from the bus. This mode is used during the normal process control service.

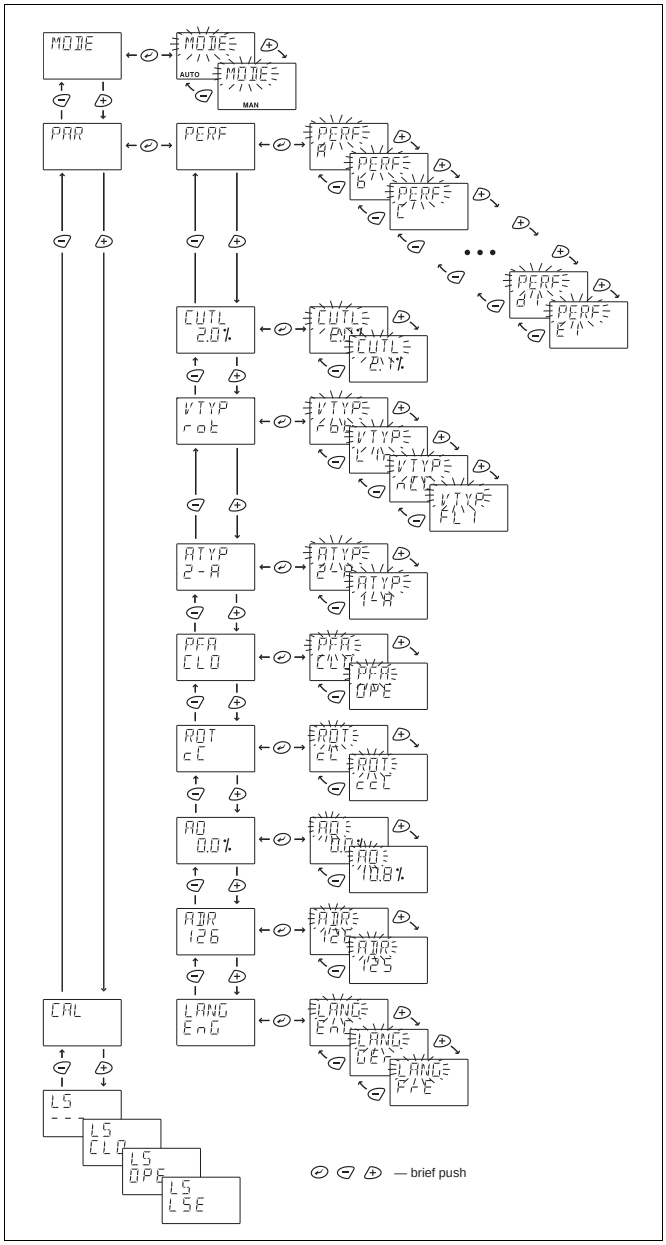


Fig. 12 Configuration

5.4.2 MAN

During this mode the valve position may be controlled manually by using the keyboard and pressing the ⊕ or ⊖ buttons. The position of the manually driven valve is not saved in the memory of the controller, i.e. the valve will not return to the same position after signal failure. However, the valve may be driven back into position after signal failure by using ⊕ and ⊖ keys.The manual control starts from the current position of the valve after the MAN-mode is activated. In order to change the manual setpoint return to the measurement monitoring view and go to target position measurement. Press the ↵ key shortly to activate the target position editing, text TPOS starts to blink and now you are able to edit the setpoint by pressing ⊕ or ⊖ button. The setpoint changes in 0.1 % increments/decrements in spite of the selected unit and the valve starts to move immediately. A continuous push changes the setpoint faster. In order to view other measurements, press the ↵ or © keys and select a measurement. Repeat the previous steps if you would like to alter the setpoint value again.

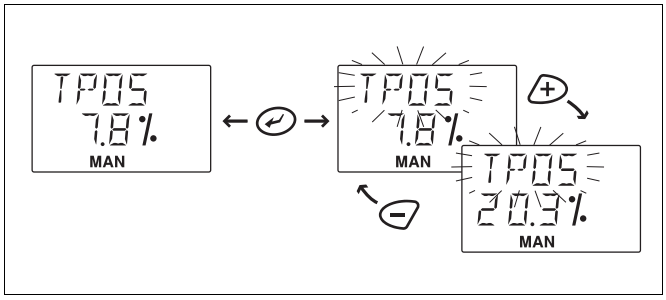


Fig. 13 Setpoint change in MAN mode

5.5 Configuration parameters

When PAR is on the display you may enter the configuration menu by pressing the ⊙ key. In this menu the most important configuration and signal modification parameters are viewable. You may view the current value and edit them by pressing the ⊙ key at the relevant parameter. The name of the parameter will appear on the upper row of the display and the current value is on the lower row.

5.5.1 Performance level, PERF

If you want to change the tuning of the valve position control, the PERF selection is available. The default factory value is C.

- ❑ Once PERF is displayed press the ⊙ key to enter the edit state and PERF starts to blink.
- ❑ Select between five values by pressing the ⊕ or ⊖ key.

Table 4 Performance level

Selection	Meaning	Description
A	Aggressive	Immediate response to signal changes, overshoots
b	Fast	Fast response to signal changes, small overshooting
C	Optimum	Very small overshoot with minimum step response time
d	Stable	No overshooting, slow response to input signal changes
E	Maximum stability	No overshooting, deadband may increase, slow but stable behaviour

For use with volume boosters and/or very fast actuators, additional performance levels A1 to D1 can be used. Characteristics of these extended levels are the same as those in the table above. However, with performance level settings A1 to D1, adaptive properties of the ND9000 control algorithm are disabled.

- ❑ After the desired value is displayed, press the key ⊙ to conclude the operation

5.5.2 Low cut-off, CUTL

Low cut-off safety range CUTL ensures the valve closing against mechanical travel stops. The factory default value is 2 %.

- ❑ Once CUTL is displayed press the ⊙ key to enter the edit state and the CUTL will start to blink. The currently selected value appears as a percentage (%) on the display.
- ❑ Modify the parameter value by pressing ⊕ or ⊖ keys alternately until the desired value appears on the display.
- ❑ After the desired value is displayed, press the key ⊙ to conclude the operation.

5.5.3 Valve type, VTYP

To compensate for nonlinearity of the position feedback caused by the actuator linkage mechanism of a linear control valve, the appropriate selection must be made on the VTYP display.

- ❑ After selecting VTYP on the display, press the ⊙ key to enter the edit state and the VTYP starts to blink.
- ❑ Select between four values rot, Lin, nCG or FLI using the ⊕ and ⊖ keys. The value rot indicates a rotary valve and Lin a linear valve. Use nCG only for nelesCV Globe valves to accommodate special linkage geometry. Use FLI only for linear valves when linkage geometry is not needed to be corrected by valve controller firmware.
- ❑ To conclude press the ⊙ key when the desired value is shown on the display.

NOTE:
Perform valve calibration and tuning always when VTYP has been changed.

5.5.4 Actuator type, ATYP

In order to optimise the control performance the device needs to be informed about the actuator type.

- ❑ After selecting ATYP on the display, press the ⊙ key to enter the edit state and ATYP starts to blink.
- ❑ Select between two values 2-A or 1-A using the ⊕ and ⊖ keys. The value 2-A indicates a double acting actuator and 1-A a single acting actuator.
- ❑ To conclude press the ⊙ key when the desired value is shown on the display.

NOTE:
Perform valve calibration and tuning always when ATYP has been changed.

5.5.5 Positioner fail action, PFA

Positioner fail action will take place in case of signal failure or when the controller software discovers a fatal device failure. For single acting actuators set value in the spring direction. For double acting actuators see Fig. 6 for correct settings.

- ❑ Once PFA is displayed, press the ⊙ key to enter the edit state and the PFA will start blinking.
- ❑ You may select between two values by pressing the ⊕ or ⊖ key. The CLO value indicates that the valve ought to be closed in fail action situations. The OPE value indicates the valve to be opened in fail action situations.
- ❑ After the desired value is displayed, press the key ⊙ to conclude the operation.

NOTE:
Perform valve calibration and tuning always when controller fail action parameter has been changed.

5.5.6 Valve rotation direction, rOT

The application-specific parameter rOT defines the relationship between position sensor rotation and valve action.

- ❑ Once rOT is displayed press the ⊙ key to enter the edit state and rOT starts to blink.
- ❑ Now you may select between two values by pressing the ⊕ or ⊖ key. The value cC indicates clockwise rotation for closing the valve and ccC means counterclockwise to close.
- ❑ After the desired value is displayed, press the key ⊙ to conclude the operation.

NOTE:
Perform valve calibration and tuning always when rOT has been changed.

5.5.7 Valve dead angle, AD

The α_0 setting is made for Metso 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° - α_0 . Use 0 % as the "dead angle" for the valves not mentioned in Table 5.

Table 5 Dead angle in percentage

Valve size		Valve series											
		MBV QMBV 1)	MBV QMBV 2)	D, P, C	T5, QT5	QX-T5	T25, QT25	QX-T25	R, QR	E	R-SOFT 3)	FL 4)	ZX
mm	in	Dead angle, %											
15	1/2												15
20	3/4												15
25	1	14	-	-	25.5	19.5	-	-	15	25.5	27		12.5
25/1	1/1											11	15
25/2	1/2											11	16.5
25/3	1/3											10	
40	1 1/2	12	-	-	24.5	12.5	-	-	12	16	21		
50	2	10	9	13.5	24.5	12.5	18	8	17	20.5	23		12.5
65	2 1/2	9	-	-	-	-	-	-	13	-	18		12.5
80	3	10	8	12	18	8	16.5	8.5	9	8.5	15.5		
100	4	10	8	12	16.5	8.5	16	9	8	7	14.5		8.5
125	5	12	-	-	-	-	12	6.5	8	-			9.5
150	6	10	8	11.5	16	9	13.5		8	13.5	13		
200	8	9	7	8.5	12	6.5	9.5		7		11.5		
250	10	9	7	7.5	13.5		9.5		7		10.5		
300	12	8	6	6.5	9.5		7.5		6		9.5		
350	14		6	6	-				5		9.5		
400	16		5	5.5	9.5 (14")				5		9.5		
450	18			6	7.5 (16")								
500	20			6					4.5				
600	24			5.5									
650	26			7									
700	28			7									
750	30			6									
800	32			-									
900	36			5.5									

1) Seat supported 2) Trunnion 3) Soft seated R-valve 4) Low Cv Finetrol

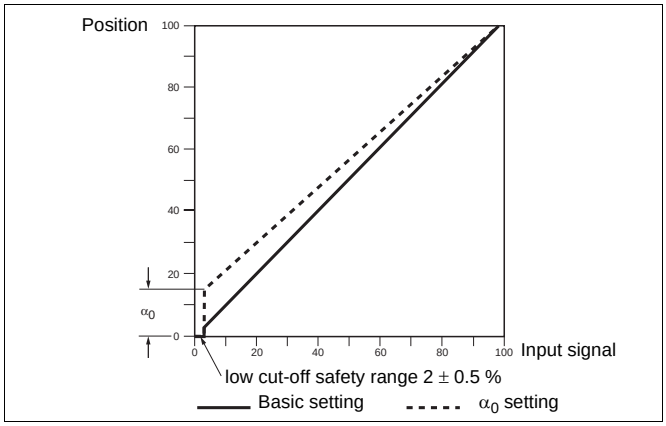


Fig. 14 Principle of setting

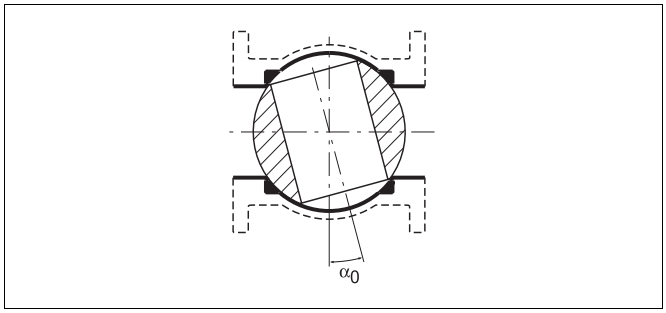


Fig. 15 Dead angle

- ❑ After selecting AD on the display, press the ⊙ key to enter the edit state and AD starts to blink. The value currently selected appears as a percentage (%) on the display.
- ❑ Modify the parameter value by pressing ⊕ or ⊖ keys alternately until the desired value appears on the display.
- ❑ Press the ⊙ key to make your selection and return to the setting state.

5.5.8 Profibus slave address setting

- ❑ You can modify the Profibus slave address by pressing ⊕ and ⊖ keys. Range is 0-126, default value is 126.
- ❑ Press the ⊙ key to make your selection and return to the setting state.

5.5.9 Language selection, LANG

- ❑ Select between three languages EnG, GEr or FrE using the ⊕ and ⊖ keys.
- ❑ To conclude press the ⊙ key when the desired value is shown on the display.

5.5.10 Low cut-off, low limit, high cut-off, high limit

ND9300P supports signal cut-off and limiting in both ends of the operating range. The configuration parameters are; low cut-off, low limit, high cut-off and high limit.

- ❑ If the input signal is smaller than low cut-off, 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 cut-off, the valve will be fully opened.

- ❑ If the input signal is greater than high limit, the valve stays in the high limit.

The cut-off overrides the limit as follows:

- ❑ If the low cut-off > low limit, the low limit is not active.
- ❑ If the low cut-off < low limit, both low cut-off and limit are active.
- ❑ If the low cut-off is set to zero, the low cut-off is not active.
- ❑ If the high cut-off < high limit, the high limit is not active.
- ❑ If the high cut-off > high limit, both high cut-off and limit are active.
- ❑ If the high cut-off is set to 100%, the high cut-off is not active.

Only the low cut-off is adjustable using the LUI. Low limit, high cut-off and high limit are configurable via fieldbus.

5.6 Valve travel calibration

NOTE:
If *AUTO CAL* or *MAN CAL* is selected, the valve controller must be in **AUTO** mode. 1-point calibration may run in both **AUTO** and **MAN** mode.

Select *CAL* from the menu by using ⊕ or ⊖ keys and press the ↵ key. Define the calibration type *AUTO*, *MAN* or *TUNE*. You may also select *TUNE* after *AUTO* and *MAN* calibration separately as seen in Fig.16.

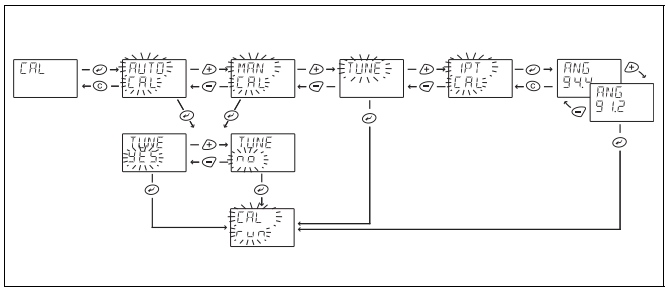


Fig. 16 Calibration selection

WARNING:
Automatic calibration drives the valve against the mechanical open and closed travel limits of the valve-actuator assembly and a tuning procedure is performed. Make sure that these procedures can be safely executed.

5.6.1 AUTO calibration function

During the calibration process the display will show the following text: *CALrun*. After calibration the ND9300P scrolls *CALIBRATION SUCCESSFUL* text. You may interrupt the calibration sequences at any time by pressing the ⓒ key.

After the calibration sequence is finished, press the ⓒ key twice to get back to the measurement view.

Please refer to Chapter 6 if this sequence has failed and an error message is displayed.

If you cannot drive the valve into a fully open position or if there is no mechanical limit stop, a manual calibration is required.

5.6.2 MAN calibration function

After selecting the *MAN* calibration function from the menu press the ↵ key to activate the procedure. With the ⊕ or ⊖ keys drive the valve manually to the closed (0 %) position and then press the ↵ key. If you cancel the operation, the old values of the previous calibration will be restored. Drive the valve into the desired maximum opening position (100 %) with the ⊕ and ⊖ keys and press the ↵ key.

If this sequence has failed and an error message is shown, see Chapter 6.

5.6.3 TUNE function

During the tuning the ND9300P controller searches for optimum internal control parameters for the valve position control. At any time you may interrupt the tuning sequence by pressing the ⓒ key. The tuning will not alter the *PERF* parameter.

If calibration and tuning are performed in sequence, the cancelling of tuning does not restore the old calibration values.

5.6.4 1-Point calibration

1-point calibration is useful in cases in which the valve controller needs to be changed but it is not possible to run the normal calibration and the valve is not allowed to change position (the valve is active, for example). **This procedure does not ensure the best possible control performance, and it is always recommended to run either AUTO or MAN calibration and tuning, as soon as possible.** The primary way to calibrate valve position is to use either **AUTO** or **MAN** calibration.

Before starting 1-point calibration, read the warnings and notes below and **check that the valve is mechanically locked. Before starting 1-point calibration, adjust the TPOS value in the MAN mode (see section 5.4.2) to correspond with the physical position of the valve.**

Once the 1-point calibration is started, the first view shows *ANG* above and *NN.N* below (see Fig. 16). *NN.N* presents the maximum turning angle (in degrees) that the valve can perform.

To change the value:

- ❑ Press ↵, *NN.N* begins blink
- ❑ Press ⊕ and ⊖ -buttons to change the value

After the correct valve operation angle is set, press ↵-button.

During the calibration process the display will show the following text: *CALrun*. After calibration the ND9300P scrolls *CALIBRATION SUCCESSFUL* text. You may interrupt the calibration sequences at any time by pressing the ⓒ key.

After the calibration sequence is finished, press the ⓒ key twice to get back to the measurement view.

Please refer to Chapter 7 if this sequence has failed and an error message is displayed.

The valve can now be unlocked.

WARNING:
Supply pressure can be connected to the valve controller only after 1-point calibration is successfully completed. If supply pressure is connected to the valve controller before successful 1-point calibration, the valve may move and cause danger.

NOTE:
If an incorrect valve operation angle is given to the valve controller during 1-point calibration, valve operation will be incorrect. In this case, you must perform 1-point calibration again with correct valve operation angle value.

NOTE:
If the valve position is not stable (due to heavy vibration etc) during 1-point calibration, the calibration will not end successfully. Check that the valve position is fully stable during this operation.

5.6.5 LS status

LS shows the status of limit switches:

---	No LS active
CLO	LS "Closed" active
OPE	LS "Open" active
LSE	LS Error, both switches activated at the same time

5.7 Special displays

5.7.1 User interface locked

In order to prevent unauthorised access, the Local User Interface may be locked. In this mode measurements may be viewed but configurations and calibrations are prohibited. You may lock and unlock the device only via dip switch, see Fig. 21. When the Local User Interface is locked the lock symbol will be activated on the display.

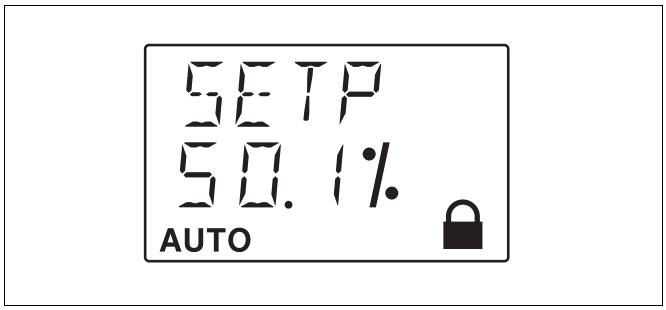


Fig. 17 LUI locked

5.7.2 Online-alarm active

If an online alarm has been detected the ✕ symbol is activated. This symbol will disappear after the recovery from online alarm. You may view the reason for the alarm by viewing the latest event while pushing the ⓒ and ⓔ keys simultaneously or by using FieldCare software where all events may be viewed.

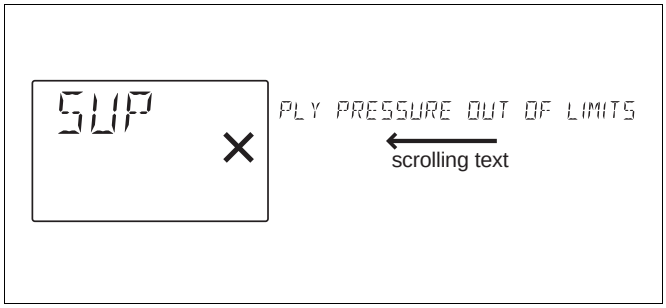


Fig. 18 Online alarm message

5.7.3 Viewing of latest event

You may view the latest event by pressing the ⓒ and ⓔ keys simultaneously in the measurement monitoring view. The message is scrolled on the top row of the display twice. You may stop the scrolling by pressing the ⓔ key. By pressing the ⓒ key, the message will disappear.

For the list of events see Chapter 6.

5.7.4 Fail-safe active

When the ND9300P detects serious device failure (setpoint, valve position and control signals) it enters failsafe mode, which drives the control valve into the position defined in the parameter controller fail action (PFA). Fail-safe mode is indicated by the display as seen in Fig. 19. The error message is displayed until the cause of error is eliminated and the ND9300P unit is restarted, i.e. the power loop is momentarily disconnected.

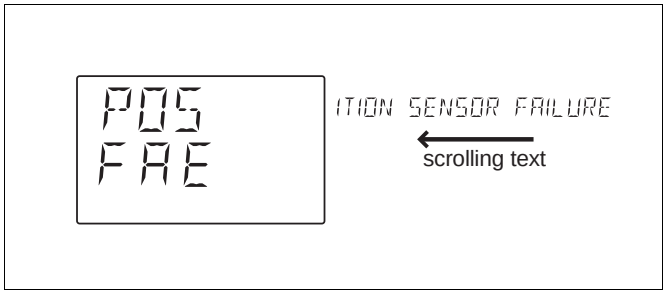


Fig. 19 Failsafe display

5.7.5 Reduced performance

When the ND9300P detects spool valve measurement failure, it enters reduced performance mode.This is indicated by the blinking ✕ in the display, see Fig. 20.

In reduced performance mode valve control can not be optimized. To correct the problem replace the spool valve assembly and perform auto calibration.

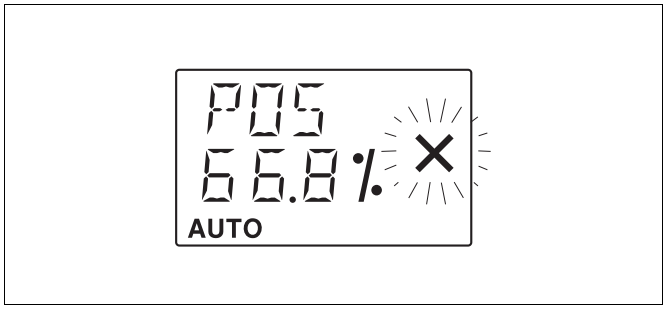


Fig. 20 Reduced performance display

5.8 Write protection

The ND9300P is delivered from the factory with HW write protection OFF as the default setting. Reading and changing parameters is thus allowed. Write protection can be enabled with the switch (DIP1) located on the circuit board (Fig. 21).

Write protection protects all write access to all writeable parameters of the device. Changing the parameters from the LUI or profibus configurator is thus not allowed.

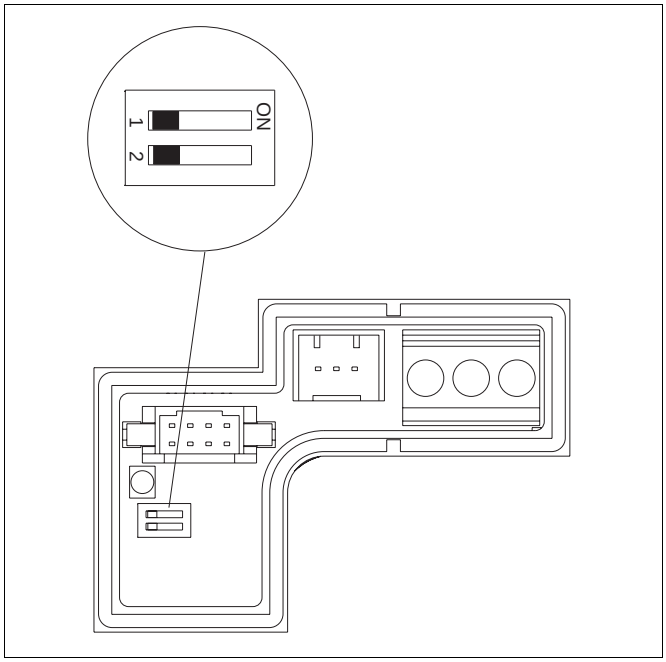


Fig. 21 Write protection

6 MAINTENANCE

The maintenance requirements of the ND9300P valve controller depend on the service conditions, for instance, the quality of instrument air. Under normal service conditions there is no requirement for regular maintenance.

When maintaining the ND9300P ensure that the supply air is shut off and pressure is released. In the following text the numbers in brackets ( ) correspond to the part numbers in the exploded view as shown in Chapter 10, unless otherwise stated.

The ND9300P valve controller includes the following interchangeable modules: prestage unit (120), spool valve (193) and communication circuit board with optional position transmitter (215).

The spool valve is located on the bottom side of the device while the other modules are located below the covers (100) and (39). In the event of failure the whole module must be changed. The module retrofit must be assembled in a clean, dry environment. In reassembly apply a thread-locking compound (for instance, Loctite 243) and tighten the screws firmly.

NOTE:
Whenever any maintenance operations have been done for the ND9300P, the device should be calibrated and tuned.

6.1 Prestage

NOTE:
The prestage must be handled carefully. In particular the moving parts of the prestage should not be touched when the inner cover (39) is not in place.

6.1.1 Removal

- ❑ Loosen the M8 stop screw (110) in the position indicator (109) and turn the position indicator from the shaft (11). Remove the inner cover (39) attached with M3 screws (42, 3 pcs).
- ❑ Unplug the prestage wire connector from the spool sensor board (180). Unscrew the M4 screws (139, 2 pcs.) and lift up the prestage module. Remove the O-ring (140).

6.1.2 Installation

- ❑ Place a new O-ring (140) into the groove in the housing and press the prestage into place. Make sure the nozzle is guided into the O-ring properly. The screws guide the prestage body into the correct position. Tighten the screws (139) evenly.
- ❑ Push the prestage 2-pole wire connector into the socket on the spool sensor board. The wire connector can only be fitted in the correct position. Replace the inner cover (39) and tighten the M3 screws.

6.2 Spool valve

6.2.1 Removal

For spool valve removal it is usually necessary to unmount the valve controller from the actuator.

- ❑ Working from the bottom side of the valve controller, unscrew the M4 screws (47, 3 pcs.). Remove the spool valve cover (61) and the spool valve (193) with gasket (174). Hold the ends of the body with your fingers to avoid dropping the spool from the body.
- ❑ Spool valve removal is only possible in the spring-forced failsafe position of the spool. In the case of a stuck spool it might be necessary to remove the secondary diaphragm cover (167), the spool spring (166) with its disc (164) and the secondary diaphragm (162) with its plate. After the removal of these parts it is possible to use a punch to force the spool to the failsafe position.
- ❑ The spool valve may be cleaned if special attention is paid to a clean environment and proper procedure.
- ❑ Clean the spool and the bore of the body with care. Do not leave any fibres from cleaning materials in the bore or on the spool. Do not scratch the mating surfaces of the spool and body.

NOTE:
Each spool valve body has an individual corresponding spool which cannot be replaced by any other spool. Never alter the orientation of the spool. The orientation of the spool is marked on the device, see Fig. 22.

6.2.2 Installation

- ❑ Ensure that the gaskets (174) and (63) are properly located in their grooves on the bottom of the housing. Mount the spool valve and the spool valve cover (61) to the housing, and tighten M4 screws evenly.

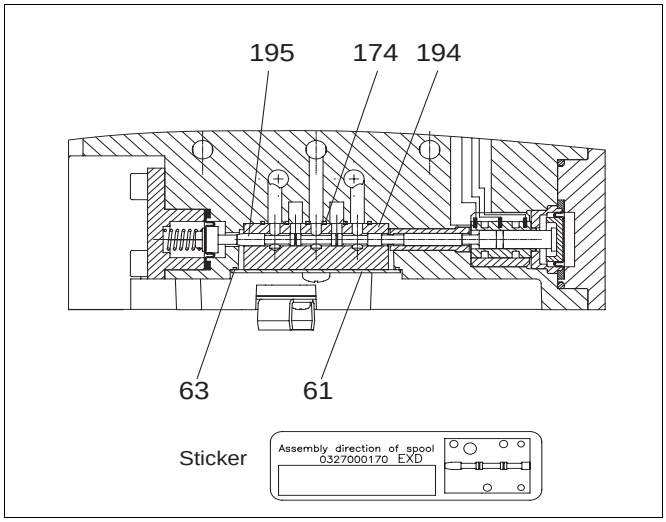


Fig. 22 Spool valve assembly

6.3 Flame arrestor assembly

The flame arrestor and the restrictor are fit into the same plug which is located under the diaphragm cover (171). This assembly can not be disassembled and should be replaced if clogged.

- ❑ To remove the flame arrestor assembly, unscrew the screws (173, 4 pcs.) and remove the diaphragm cover (171) with its O-ring. Turn a M3 screw into the threaded hole of the flame arrestor assembly to extract it from the housing. Installation is the reversal of removal. Place the O-rings carefully.

6.4 Diaphragms

The diaphragms (169, 162) may be replaced by removing the respective covers (171, 167). The unit should be unmounted from the actuator and the side to be worked on turned upwards in order to avoid loss of small parts. When replacing the secondary diaphragm (162), the spool spring (166) with its guide (164) has to be removed first. When reassembling, pay special attention to the installation of the diaphragms and O-rings.

NOTE:
If the maintenance operations have been done for the spool valve assembly, the device **must** always be calibrated and tuned.

6.5 Communication circuit board

6.5.1 Removal

- ❑ Loosen the M8 stop screw (110) in the position indicator (109) and turn the position indicator from the shaft (11). Remove the inner cover (39) attached with M3 screws (42, 3 pcs.).

NOTE:
Ground yourself on the body of the device before touching the circuit board.

- ❑ Remove the M3 screws (217, 4 pcs.). Hold the sides of the circuit board and lift it directly upwards and outwards. Handle the board carefully, touching only the sides.

NOTE:
Do not remove the Valve Controller Board (210)!
Removing the board will void the warranty.

6.5.2 Installation

- ❑ Mount the new communication circuit board carefully.
- ❑ Locate the pins with the matching connector on the board. Tighten the M3 screws (217) evenly.
- ❑ Install the inner cover (39).
- ❑ Mount the position indicator (109) on the shaft and tighten the M8 stop screw (110) temporarily. The final orientation and locking of the position indicator should be done after installation of the valve controller to the actuator.

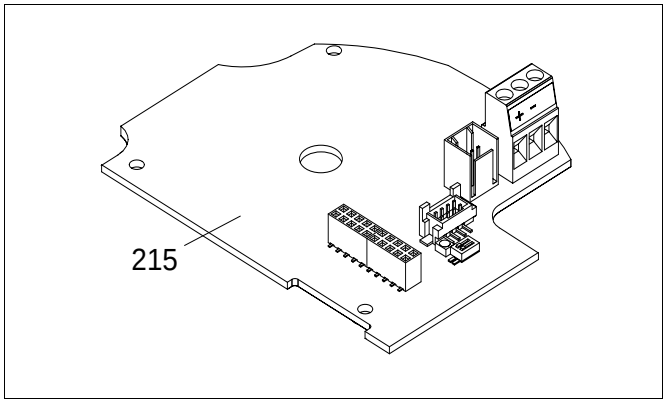


Fig. 23 Communication board

7 ERROR MESSAGES

7.1 Failsafe errors

Display message	Description
POSITION SENSOR FAILURE	Position sensor measurement failed. Change the ND9000 device to a new one.
PRESTAGE SHORTCUT ERROR	Shortcut in the prestage unit.
FAE nnn	Fatal malfunction in the device. nnn is a number between 001 - 004. Change the ND9000 device to a new one.

7.2 Alarms

Display message	Description
DEVIATION ALARM	Valve deviation out of limits.
STICTION LOW ALARM	Stiction has exceeded the low limit.
STICTION HIGH ALARM	Stiction has exceeded the high limit.
LOAD FOR OPENING LOW ALARM	Load for opening has exceeded the low limit.
LOAD FOR OPENING HIGH ALARM	Load for opening has exceeded the high limit.
SPOOL VALVE PROBLEM	Spool valve problem in the controller. Check the spool valve unit and replace if necessary.
PNEUMATICS PROBLEM	Inconsistent actuator pressures. Check pneumatic connections and actuator leakage.
FRICTION PROBLEM	Valve is not moving correctly. Check load factor.

7.3 Errors

Display message	Description
PRESTAGE CUT ERROR	Prestage wire is cut or connector is loose.
PRESSURE SENSOR 1 FAILURE	Actuator pressure sensor has failed. The device performance level is reduced. Change the ND9000 device to a new one during next maintenance activity.
PRESSURE SENSOR 2 FAILURE	Actuator pressure sensor has failed. The device performance level is reduced. Change the ND9000 device to a new one during next maintenance activity.
PRESSURE SENSOR 3 FAILURE	Supply pressure sensor has failed. This does not affect the performance level.
SPOOL VALVE SENSOR FAILURE	Spool valve sensor failed. Check the sensor connections. The device performance level is reduced. Change the ND9000 device to a new one during next maintenance activity.
TEMPERATURE SENSOR FAILURE	Temperature measurement failed. The accuracy of the measurements is reduced. Change the ND9000 device to a new one during next maintenance activity.
STATISTICS DATABASE ERROR	Failed to store statistics. New measurements will be lost.
EVENT DATABASE ERROR	Failed to store events. The new events will be lost.
POSITION CALIBRATION FAILED	Travel calibration failed. Check the configuration parameters and controller mounting. Check that the controller shaft is correctly aligned.
TUNING FAILED	Tuning procedure failed. Check that the valve is moving properly. Check the prestage and spool valve unit.
POSITION SENSOR RANGE ERROR	Position sensor range failed during calibration. Valve controller shaft failed to rotate minimum 45 degrees. Check the configuration parameters and controller mounting. Check that the controller shaft is correctly aligned.
CALIBRATION TIMEOUT	Calibration timeout occurred. Check configuration and installation.
CALIBRATION START FAILED	The calibration starting conditions are not met. Check the supply pressure.
TUNING RANGE ERROR	Tuning procedure failed. Check the prestage and spool valve unit.
SPOOL SENSOR RANGE ERROR	Spool sensor range failed during position calibration. Check the configuration parameters. Check the prestage and spool valve unit.

7.4 Warnings

Display message	Description
TOTAL OPERATION TIME WARNING	Operating time exceeded limit.
VALVE FULL STROKES WARNING	Valve stroke counter limit reached.
VALVE REVERSALS WARNING	Valve reversals counter limit reached.
ACTUATOR FULL STROKES WARNING	Actuator stroke counter limit reached.
ACTUATOR REVERSALS WARNING	Actuator stroke counter limit reached.
SPOOL FULL STROKES WARNING	Spool stroke counter limit reached.
SPOOL REVERSALS WARNING	Spool reversals counter limit reached.
STEADY STATE DEVIATION WARNING	Warning that steady state deviation has increased.
DYNAMIC STATE DEVIATION WARNING	Warning that dynamic state deviation has increased.
STICTION LOW WARNING	Warning that stiction has exceeded the low limit.
STICTION HIGH WARNING	Warning that stiction has exceeded the high limit.
LOAD FOR OPENING TOO LOW	Warning that load for opening has exceeded the low limit.
LOAD FOR OPENING TOO HIGH	Warning that load for opening is has exceeded the high limit.
SUPPLY PRESSURE OUT OF LIMITS	Supply pressure has exceeded the specified operating conditions.
TEMPERATURE OUT OF LIMITS	Temperature has exceeded the specified operating conditions.
HUNTING DETECTION WARNING	Valve hunting detected. Change performance level to less aggressive to stabilize valve. Check that the spool valve capacity is suitable for the actuator.
REDUCED PERFORMANCE ACTIVATED	Valve controller performance is reduced due to defective spool valve sensor. Change the spool valve assembly.
TOO LOW SUPPLY PRESS FOR 1-ACT ACTUATOR	Too low supply pressure level for 1-acting actuator.
VALVE REVERSALS TREND WARNING	Warning that valve reversals per day has exceeded the limit.
SETPOINT REVERSALS TREND WARNING	Warning that setpoint reversals per day has exceeded the limit.
VALVE TRAVEL TREND WARNING	Warning that valve travel per day has exceeded the limit.
VALVE REVERSALS WH STABLE SETP WARNING	Warning that valve reversals while setpoint is stable, per day, has exceeded the limit

7.5 Notifications

Display message	Description
CALIBRATION SUCCESSFULL	Position calibration successfully performed.
TEST CANCELLED	Off-line test has been cancelled.
TEST DONE	Off-line test has been successfully performed.
TEST FAILED	Off-line test failed. Repeat the test sequence.
CALIBRATION CANCELLED	Calibration has been cancelled.
PARAMETERS BACKUP RESTORED	Parameter backup database has been activated.
PT NOT ACTIVATED	(Only with position transmitter option). The position transmitter is not energized.
1PT CAL FAILED	1-point calibration failed. Check the mounting of the valve controller. Verify input parameter (range) value. Check rotation parameter (ROT).
TUNE OK	Tuning has been successfully performed.
REDUCED PERFORMANCE DEACTIVATED	Spool valve measurement and normal valve control is recovered.

8 TROUBLE SHOOTING

Mechanical/electrical defects

1. A change in the valve position setpoint will not affect the position of the actuator

- ❑ Supply pressure too low
- ❑ Spool valve sticks
- ❑ Incorrect configuration parameters
- ❑ Actuator and/or valve jammed
- ❑ Signal wires incorrectly connected, no value on display
- ❑ Circuit boards are defective
- ❑ Calibration and tuning has not been carried out
- ❑ Device is in manual mode
- ❑ Prestage is defective
- ❑ Device is in fail-safe mode

2. The actuator goes to the end position with a small change of input signal

- ❑ Tubes between controller and actuator are incorrect, see Fig. 6
- ❑ The parameter settings *PFA* and *ROT* are incorrectly selected.

3. Inaccurate positioning

- ❑ Spool valve dirty
- ❑ Too high actuator load
- ❑ Supply pressure too low
- ❑ Spool or pressure sensors are defective
- ❑ Actuator leakage

4. Overshooting or positioning too slow

- ❑ Change *PERF* value
- ❑ Spool valve dirty
- ❑ Supply air tube too small or supply air filter dirty
- ❑ Valve sticks
- ❑ Check leakages in tubes between controller and actuator
- ❑ Check leakages in mechanical stop screws

5. Error during valve travel calibration

- ❑ Valve controller is in *MAN* mode
- ❑ Check the coupling alignment with the pointer, see Fig. 5.
- ❑ The parameter settings *PFA* and *ROT* are incorrectly selected
- ❑ The actuator or valve did not move or was stuck during calibration
- ❑ Supply pressure too low
- ❑ Spool valve dirty

9 TOOLS

No special tools required.

10 ORDERING SPARE PARTS

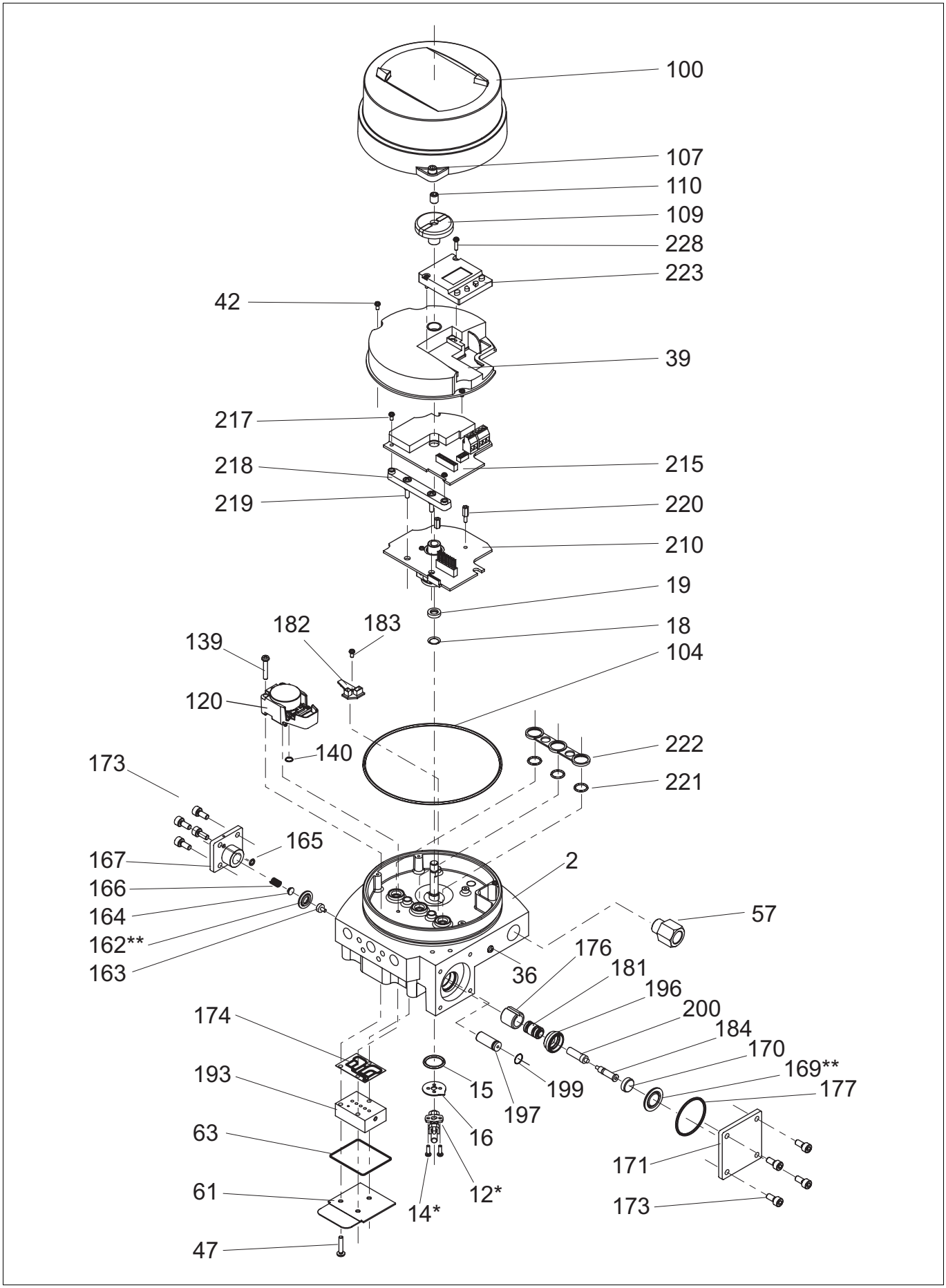
Spare parts are delivered as modules. The modules available are indicated in 10.1.

When ordering spare parts, always include the following information:

- ❑ Valve controller type designation and serial number from the ID plate
- ❑ The code of this manual, the part number, the part name and quantity required

11 DRAWINGS AND PARTS LISTS

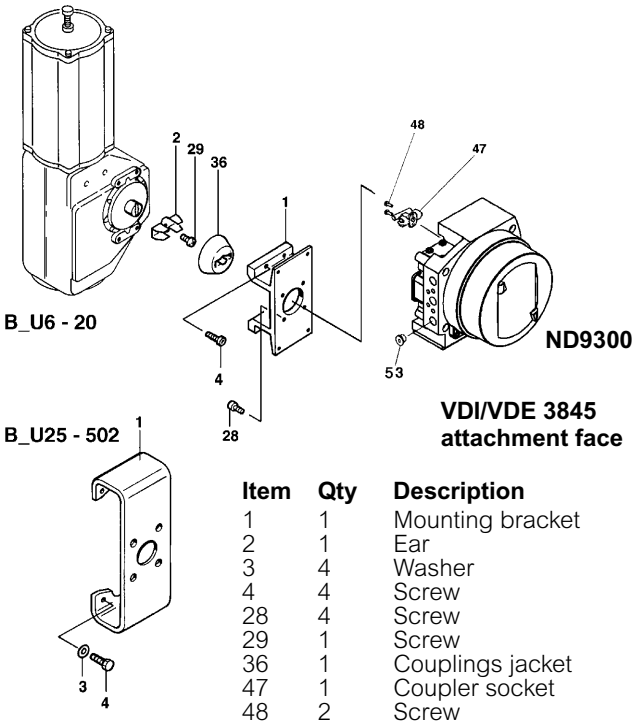
11.1 Exploded view and parts list, ND9300P



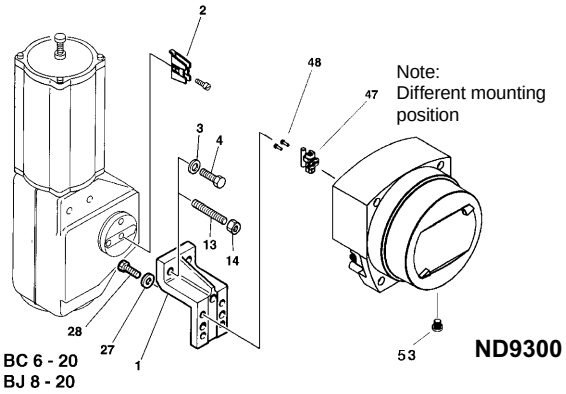
Item	Qty	Description	Spare modules
2	1	Housing	
15	1	O-ring	
16	1	Washer	
18	1	Wave spring	
19	1	Bushing	
36	1	Grounding screw	
39	1	Inner cover	
42	3	Screw	
47	3	Screw	
57	1	Conduit entry adapter	
61	1	Spool valve cover	
63	1	Gasket	
100	1	Cover	x
104	1	O-ring	
107	1	Screw	
109	1	Pointer	
110	1	Stop screw	
120	1	Prestage unit	x
139	2	Screw	
140	1	O-ring	
162**	1	Supply pressure diaphragm	x
163	1	Diaphragm plate	
164	1	Spring guide	
165	1	O-ring	
166	1	Spring	
167	1	Diaphgram cover	
169**	1	Pilot pressure diaphgram	x
170	1	Diaphragm plate	
171	1	Diaphragm cover	
173	8	Screw	
174	1	Gasket	
176	1	Bushing	
177	1	O-ring	
181	1	Sleeve	
182	1	Spool sensor board	
183	1	Screw	
184	1	Plunger	
193	1	Spool valve	x
196	1	Bushing	
197	1	Flame arrester assembly	x
199	1	O-ring	
200	1	Flame arrester plunger	
210	1	Controller circuit board	
215	1	Communication circuit board	x
217	4	Screw	
218	1	Support	
219	2	Screw	
220	2	Threaded spacer	
221	3	O-ring	
222	1	Isolation part	
223	1	Local user interface (LUI)	x
228	2	Screw	

*) Mounting parts: coupling (12), screws (14)
**) Diaphgram set

11.2 Mounting parts for B1C/B1J 6-20 actuators



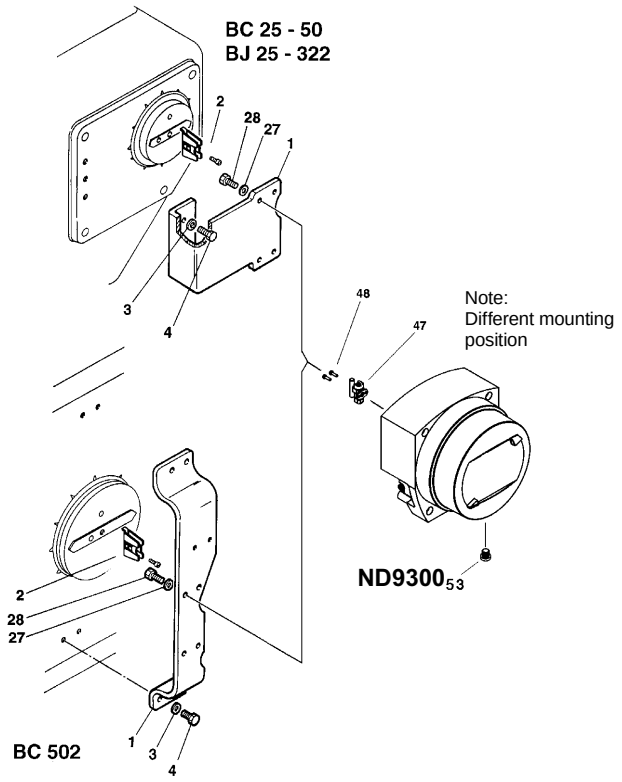
Item	Qty	Description
1	1	Mounting bracket
2	1	Ear
3	4	Washer
4	4	Screw
28	4	Screw
29	1	Screw
36	1	Couplings jacket
47	1	Coupler socket
48	2	Screw
53	1	Plug (BJ actuators only)



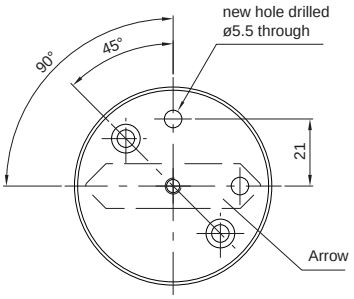
Item	Qty	Description
1	1	Mounting bracket
2	1	Draught piece
3	4	Washer
4	4	Screw
13	2	Screw
14	2	Hexagon nut
28	4	Screw
29	1	Screw
47	1	Coupler socket
48	2	Screw
53	1	Plug (BJ actuators only)

Note: See 11.3 for old series B actuators

11.3 Mounting parts for B1C/B1J 25-50, B1C 502 and B1J322 actuators

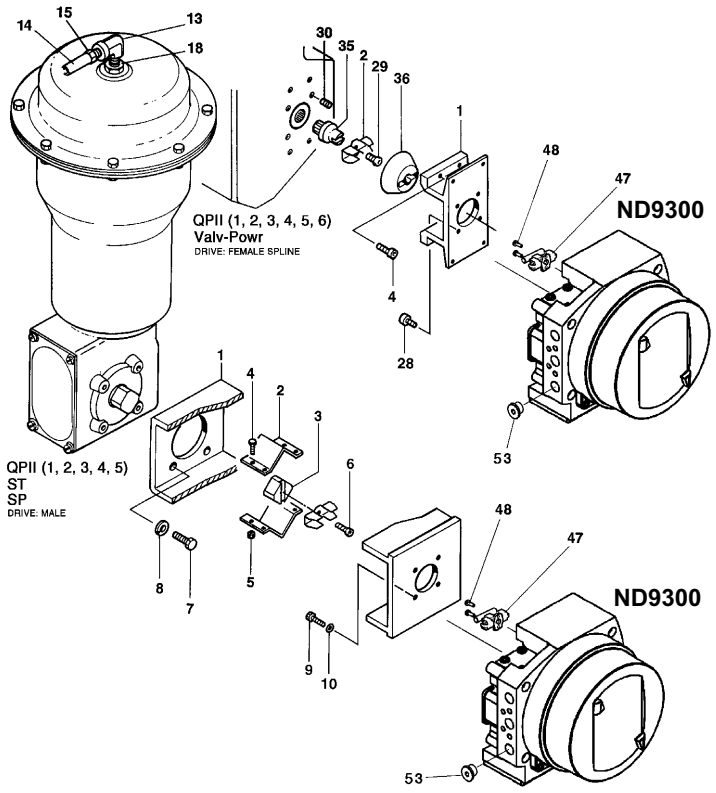


Note: Old series B actuators



Item	Qty	Description
1	1	Mounting bracket
2	1	Draught piece
3	4	Washer
4	4	Screw
27	4	Washer
28	4	Screw
47	1	Coupler socket
48	2	Screw
53	1	Plug (BJ actuators only)

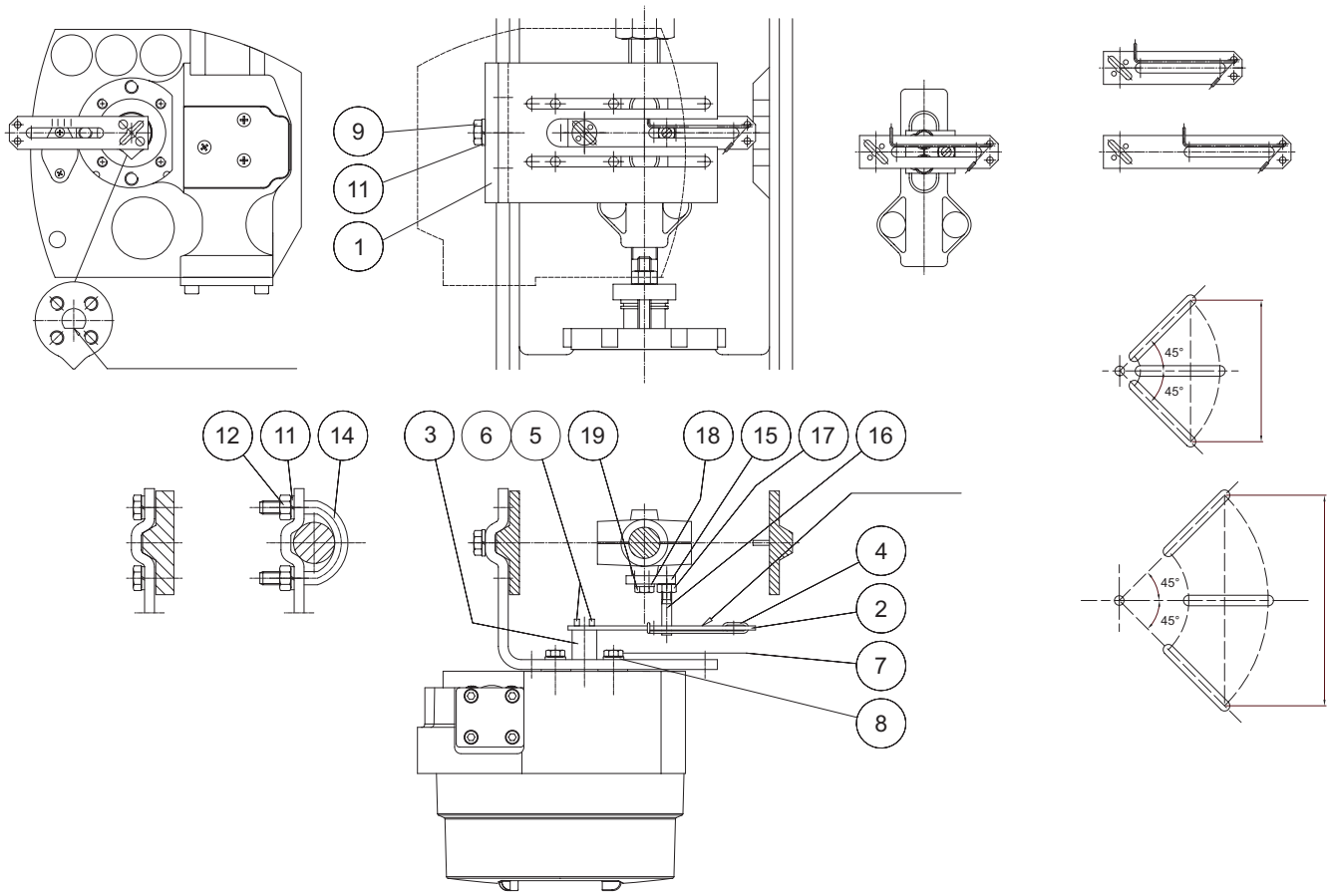
11.4 Mounting parts for Quadra-Powr® actuators



Item	Qty	Description
1	1	Mounting bracket
2	1	Ear
4	4	Screw
28	4	Screw
29	1	Screw
30	4	Screw
35	1	Adapter plug (QP II 1/S- 6/S only)
35	1	Adapter plate (QP II 2B/K thr. 6_/K)
36	1	Couplings jacket
47	1	Coupler socket
48	2	Screw
53	1	Plug

Item	Qty	Description
1	1	Mounting bracket
2	2	Coupling half
3	1	Adapter
4	4	Screw
5	4	Hex nut
6	1	Screw
7	4	Screw
8	4	Washer
9	4	Screw
10	4	Washer
47	1	Coupler socket
48	2	Screw
53	1	Plug

11.5 Mounting parts for linear actuators

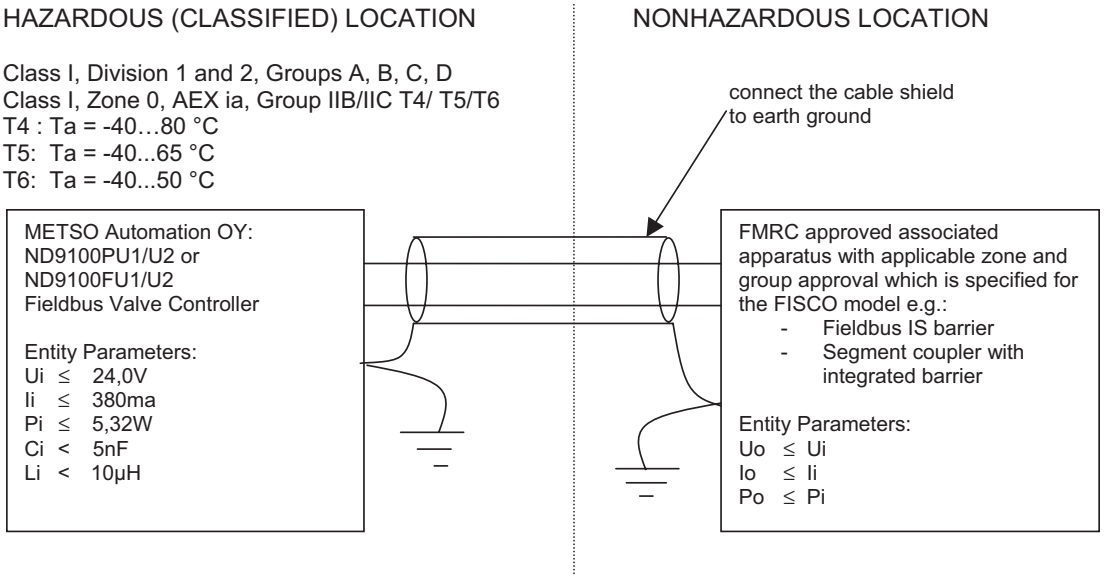


Item	Qty	Description
1	1	Bracket
2	1	Feedback lever
3	1	Filling piece
4	1	Clearance remove spring
5	4	Cross rec head screw
6	4	Washer
7	4	Hexagon screw
8	4	Washer
9	4	Hexagon screw
11	4	Spring washer
12	2	Hexagon nut
14	2	Clamp
15	1	Fixing plate
16	1	Special screw
17	1	Hexagon nut
18	2	Washer
19	2	Hexagon screw
54	2	Plug

11.6 Control drawing

1 FMRC and CSA Option: ND9100PU1 and ND9100FU1 (ND9100PU2 and ND9100FU2)

This concept may only be applied if all devices at the fieldbus line are approved and specified for the FISCO model, also the barrier or Segment coupler must be specified for the FISCO model.



FISCO rules

The FISCO Concept allows the interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such combination. The criterion for such interconnection is that the voltage (Ui), the current (Ii) and the power (Pi) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, must be equal or greater than the voltage (Uo, Voc, Vt), the current (Io, Isc, It,) and the power (Po) which can be provided by the associated apparatus (supply unit). In addition, the maximum unprotected residual capacitance (Ci) and inductance (Li) of each apparatus (other than the terminators) connected to the Fieldbus must be less than or equal to 5 nF and 10 µH respectively.

In each I.S. Fieldbus segment only one active source, normally the associated apparatus, is allowed to provide the necessary power for the Fieldbus system. The allowed voltage (Uo, Voc, Vt) of the associated apparatus used to supply the bus must be limited to the range of 14V d.c. to 24V d.c. All other equipment connected to the bus cable has to be passive, meaning that the apparatus is not allowed to provide energy to the system, except to a leakage current of 50 µA for each connected device. Separately powered equipment needs a galvanic isolation to insure that the intrinsically safe Fieldbus circuit remains passive.

The cable used to interconnect the devices needs to comply with the following parameters:

Loop resistance R': 15 ...150 Ω/KM
Inductance per unit length L': 0.4…1mH/km
Capacitance per unit length C': 80 ...200 nF/km
C' = C' line/line + 0.5 C' line/screen, if both lines are floating
or
C'= C' line/line + C' line/screen, if the screen is connected to one line
Length of spur Cable: max. 30m
Length of trunk cable: max. 1Km
Length of splice: max. 1m

Terminators

At each end of the trunk cable an approved line terminator with the following parameters is suitable:
R = 90 ...100 Ω
C = 0 ...2.2 µF.

System evaluation
The number of passive devices like transmitters, actuators, connected to a single bus segment is not limited due to I.S. reasons. Furthermore, if the above rules are respected, the inductance and capacitance of the cable need not to be considered and will not impair the intrinsic safety of the installation.

Installation Notes for FISCO Concepts in FM:

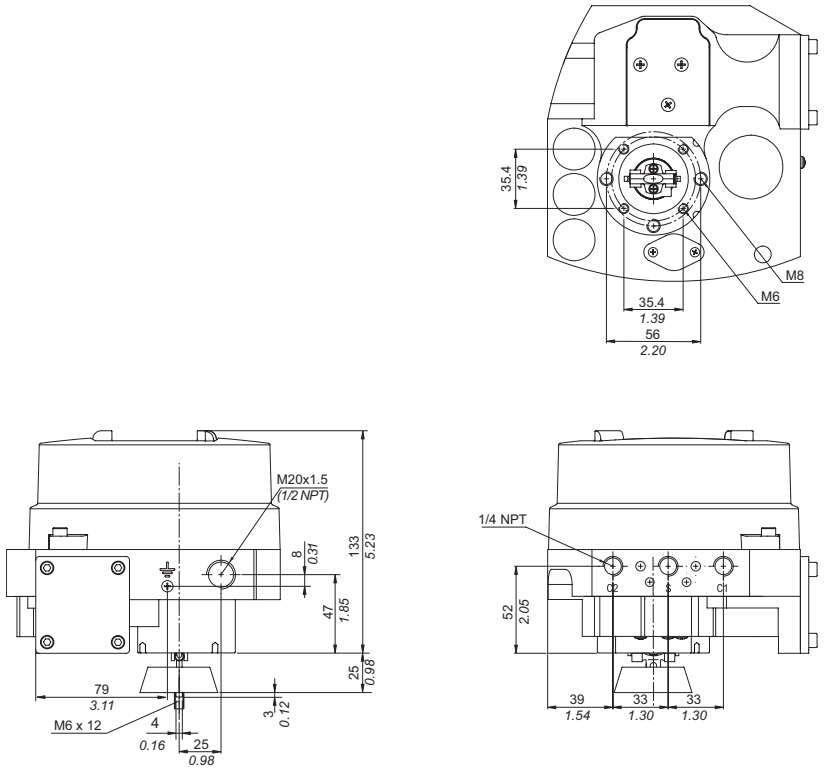
1. The Intrinsic Safety FISCO concept allows the interconnection of FM Approved Intrinsically safe devices with FISCO parameters not specifically examined in combination as a system when:
   Uo or Voc or Vt ≤ Ui, Io or Isc or It ≤ Ii, Po ≤ Pi.
2. Control equipment connected to the Associated Apparatus must not use or generate more than 250 Vrms or Vdc.
3. Installation should be in accordance with ANSI/ISA RP12.06.01 (except chapter 5 for FISCO Installations) “Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations” and the National Electrical Code® (ANSI/NFPA 70) Sections 504 and 505.
4. The configuration of associated Apparatus must be Factory Mutual Approved under the FISCO concept.
5. Associated Apparatus manufacturer’s installation drawing must be followed when installing this equipment.
6. The ND9100P / ND9100F Series Valve Controllers are Approved for Class I, Zone 0, applications. If connecting AEx[ib] Associated Apparatus or AEx ib I.S. Apparatus to the ND9100P / ND9100F Series Valve Controller Fieldbus System, the ND9100P / ND9100F Series Valve Controller is only suitable for Class I, Zone 1, or Class I, Zone 2, and is not suitable for Class I, Zone 0 or Class I, Division 1, Hazardous (Classified) Locations.". In addition, if any Associated Apparatus or I.S. device connected to the Fieldbus System is rated for IIB only, the ND9100P / ND9100F Series Valve Controllers must only be installed in a Group IIB environment
7. The metallic enclosure of the ND9000 valve controller must be grounded and bonded in accordance with the National Electrical Code ANSI / NFPA 70, Article 250
8. The cover of the ND9000 enclosure may be removed in hazardous location for reading the display and operating the push buttons. The internal cover of the electronic circuits must not be removed in hazardous areas.
9. The shield in the field wiring cable shall be connected to the earth ground of the shunt diode / FISCO supply barrier in the unclassified location.
10. If you agree, please revise the control drawing by adding this note.
11. The valve controllers ND9100P/U2 and ND9100F/U2 are non-incendive for Class I, Division 2, Groups A,B,C and D; Class I, Zone 2, Groups IIC, IIB, IIA T4 / T5 / T6 hazardous (classified) locations and need to be connected to an associated apparatus with a max. output voltage of 24,0V.
12. No revision to drawing without prior Factory Mutual Approval.

Installation Notes for FISCO Concepts in CSA:

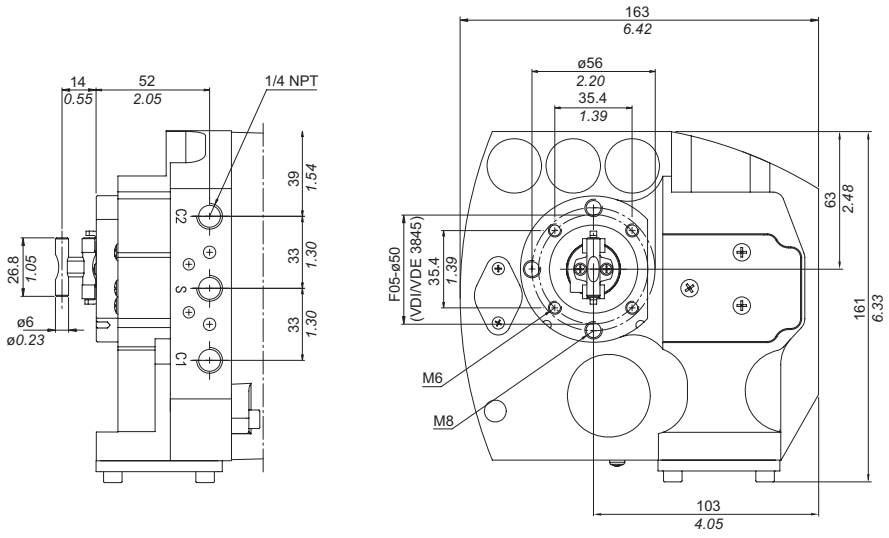
13. The Intrinsic Safety FISCO concept allows the interconnection of CSA Approved Intrinsically safe devices with FISCO parameters not specifically examined in combination as a system when:
    Uo or Voc or Vt ≤ Ui, Io or Isc or It ≤ Ii, Po ≤ Pi.
14. Control equipment connected to the Associated Apparatus must not use or generate more than 250 Vrms or Vdc.
15. Installation should be in accordance with the Canadian Electrical Code CSA C22.1 Part 1.
16. The configuration of associated Apparatus must be CSA Approved under the FISCO concept.
17. Associated Apparatus manufacturer’s installation drawing must be followed when installing this equipment.
18. The ND9000P / ND9000F Series Valve Controllers are Approved for Class I, Zone 0, applications. If connecting AEx[ib] Associated Apparatus or AEx ib I.S. Apparatus to the ND9000P / ND9000F Series Valve Controller Fieldbus System, the ND9000P / ND9000F Series Valve Controller is only suitable for Class I, Zone 1, or Class I, Zone 2, and is not suitable for Class I, Zone 0 or Class I, Division 1, Hazardous (Classified) Locations.". In addition, if any Associated Apparatus or I.S. device connected to the Fieldbus System is rated for IIB only, the ND9000P / ND9000F Series Valve Controllers must only be installed in a Group IIB environment
19. The metallic enclosure of the ND9000 valve controller must be grounded and bonded in accordance with the Canadian Electrical Code CSA C22.1
20. The cover of the ND9000 enclosure may be removed in hazardous location for reading the display and operating the push buttons. The internal cover of the electronic circuits must not be removed in hazardous areas.
21. The shield in the field wiring cable shall be connected to the earth ground of the shunt diode / FISCO supply barrier in the unclassified location.
22. The valve controllers ND9100PU2 and ND9100FU2 are non-incendive for Class I, Division 2, Groups A,B,C and D; Class I, Zone 2, Groups IIC, IIB, IIA T4 / T5 / T6 hazardous (classified) locations and need to be connected to an associated apparatus with a max. output voltage of 24,0V.
23. No revision to drawing without prior CSA Approval.

12 DIMENSIONS

ND9300



ND9300



13 EC DECLARATION OF CONFORMITY

metso

CE

Ex

EC DECLARATION OF CONFORMITY

Manufacturer:
Metso Automation Oy
00811 Helsinki
Finland

Product: **Intelligent Valve Controller Neles ND 9000-series**

Approvals:

Type	Approval	EC Type examination Certificate
ND 9…PA (Profibus PA)	(EMC 2004/108/EC) EN61000-6-2(2001)	NEMKO 101425 & NEMKO 1052749
ND9…F (Foundation Fieldbus)	(EMC 2004/108/EC) EN61000-6-2(2001)	(Same HW as ND9...PA)
ND9…HNT (Hart)	(EMC 2004/108/EC) EN61000-6-3(2001) EN61000-6-2(2001), FCC 47 CFR Part 15, subpart B, Class B (2002)	NEMKO 56164 & NEMKO 80628
ND910.HX1, ND930.HX1 ND910.FX1, ND930.FX1 ND910.PX1, ND930.PX1	ATEX II 1 G Ex ia IIC T4/T5/T6 Ga ATEX II 1 D Ex tD A20 T90 °C	VTT 09ATEX 033X
ND910.HX2, ND930.HX2 ND910.FX2, ND930.FX2 ND910.PX2, ND930.PX2	ATEX II 2 G Ex ia IIC T4/T5/T6 Gb ATEX II 2 D Ex tD A21 T90 °C	
ND910.HX3, ND930.HX3 ND910.FX3, ND930.FX3 ND910.PX3, ND930.PX3	ATEX II 3 G Ex nA IIC T4/T5/T6 ATEX II 3 D Ex tD A22 T90 °C	VTT 09ATEX 034X
ND910.HX4, ND930.HX4 ND910.FX4, ND930.FX4 ND910.PX4, ND930.PX4	ATEX II 3 G Ex nL IIC T4/T5/T6 ATEX II 3 D Ex tD A22 T90 °C	
ND920..E1, ND930..E1	ATEX II 2 G Ex d IIC T4…T6 ATEX II 2 GD Ex tD A21 IP66 T 100°C	KEMA 04ATEX2098X

Applicable directives:
EMC 2004/108/EC Electrical
ATEX 94/9/EC Approved and Ex marked types

As the products within our sole responsibility of design and manufacture may be used as parts or components in machinery and are not alone performing functions as described in Article 6(2) in the Machinery Directive (2006/42/EC), we declare that our product(s) to which this Declaration of Conformity relates must NOT be put into service until the relevant machinery into which it is to be incorporated has been declared in conformity with the provisions of the Machinery Directive.

The product above is manufactured in compliance with the applicable European directives and technical specifications/standards.

Protection from e.g. static electricity caused by the process or connected equipment must be considered by the user (EN 60079-14 §6).

The product do not possess any residual risk according to hazard analyses made under the applicable directives providing that the procedures stated by the Installation, Operation and Maintenance manual are followed and the product is used under conditions mentioned in the technical specifications.

Manufacturer's certificates:

Standard / Directive	Notified Body	Certificate No.
ISO 9001:2000	DNV	24888-2008-AQ-FIN-FINAS
ATEX 94/9/EC Annex IV	DNV 0575	DNV-2006-OSL-ATEX-0260Q

Helsinki 29th September 2009

Ralf Liljestrand, Quality Manager
Authorized person of the manufacturer within the European Community

14 TYPE CODING

INTELLIGENT VALVE CONTROLLER ND9300P

1.	2.	3.	4.	5.	6.	7.	
ND	**9**	**30**	**3**	**P**	**E1**	**M**	**/**

1.	**PRODUCT GROUP**
ND	Intelligent Valve Controller

2.	**SERIES CODE**
9	Series 9000 valve controller with universal shaft and attachment face according to standard VDI/VDE 3845, EC/EJ actuators and Metso standard. Relevant shaft adapter included in mounting kits. When valve controllers are separate deliveries, shaft adapter kit is supplied.

3.	**ENCLOSURE**
30	Flameproof stainless steel (Ex d) IP66 / NEMA 4X enclosure

4.	**SPOOL VALVE**	**PNEUMATIC CONNECTIONS (S, C1, C2)**
2	Low capacity. Stroke volume of actuator < 1 dm^3	1/4 NPT
3	Medium capacity. Stroke volume of actuator 1...3 dm^3	1/4 NPT
6	High capacity. Stroke volume of actuator > 3 dm^3	1/4 NPT

5.	**COMMUNICATION / INPUT SIGNAL RANGE**
P	Profibus PA, physical layer according to IEC 61158-2.

6.	**APPROVALS OF STANDARD ENCLOSURE VALVE CONTROLLER**
N	No approvals for hazardous areas. M20 x 1.5 conduit entry. Temperature range -40° to +85 °C / -40° to +185 °F.
X1	**ATEX certifications:** II 1 G, Ex ia IIC T4/T5/T6 Ga II 1 D, Ex tD A20 T90 °C (EN 60079, EN 60070, EN 61241) **ND93_PX1:** Ui ≤ 24 V, Ii ≤ 380 mA, Pi ≤ 5.32 W, Ci < 5 nF, Li < 10 µH M20 x 1.5 conduit entry. Temperature range: T4; -40° to +80 °C / -40° to +176 °F. T5; < +65 °C / +149 °F, T6; < +50 °C / +122 °F. Not available with limit switches with 8. sign I or K.
X3	**ATEX certifications:** II 3 G, Ex nA IIC T4/T5/T6 II 3 D, Ex tD A22 T90 °C (EN 60079, EN 60070, EN 61241) **ND93_PX3:** Ui ≤ 24 V, Ci < 5 nF, Li < 10 µH M20 x 1.5 conduit entry. Temperature range: T4; -40° to +85 °C / -40° to +185 °F T5; < +75 °C / +167 °F, T6; < +60 °C / +140 °F.
X4	**ATEX certifications:** II 3 G, Ex nA IIC T4/T5/T6 II 3 D, Ex tD A22 T90 °C (EN 60079, EN 60070, EN 61241) **ND93_PX4:** Ui ≤ 32 V, Ii ≤ 380 mA, Pi ≤ 5.32 W, Ci ≤ 5 nF, Li ≤ 10 µH, , M20x1.5 conduit entry. Temperature range: T4; -40° to +85 °C / -40° to +185 °F, T5; < +75 °C / +167 °F, T6; < +60 °C / +140 °F.
U1	**FM and CSA certifications:** IS Class I, Division 1, Groups A, B, C, D, T4...T6 IS Class I, Zone 0, AEx ia, IIC T4...T6 **ND93_PU1:** Ui ≤ 24 V, Ii ≤ 380 mA, Pi ≤ 5.32 W, Ci < 5 nF, Li < 10 µH. M20 x 1.5 conduit entry. Temperature range: T4; -40° to +80 °C / -40° to +176 °F, T5; < +65 °C / +149 °F, T6; < +50 °C / +122 °F.
U2	**FM and CSA certifications:** NI Class I, Division 2, Groups A, B, C, D, T4...T6. NI Class I, Zone 2, Ex nA IIC T4...T6. No Zener Barrier needed. **ND93_PU2:** Ui ≤ 24 V, Ii ≤ 380 mA, Pi ≤ 5.32 W, Ci < 5 nF, Li < 10 µH M20 x 1.5 conduit entry. Temperature range: T4; -40° to +85 °C / -40° to +185 °F, T5; < +70 °C / +158 °F, T6; < +55 °C / +131 °F.
Z1	**INMETRO certifications:** BR-Ex ia IIC T4/T5/T6 IP66 (IEC 60079-0/00, IEC 60079-11/99, NBR 8447/89, IEC 60529/01) **ND93_PZ1:** Ui ≤ 24 V, Ii ≤ 380 mA, Pi ≤ 5.32 W, Ci < 5 nF, Li < 10 µH. M20 x 1.5 conduit entry. Temperature range: T4: -40° to +80 °C / -40° to +176 °F T5: < +65 °C / < +149 °F ; T6: < +50 °C / < +122 °F.
Z3	**INMETRO certifications:** BR-Ex nA II / nL IIC T4/T5/T6 IP66 (IEC 60079-0/00, NBR 9518/97, IEC 60079-15/01, IEC 60529/01) **ND93_PZ3:** Ui ≤ 24 V, Ci < 5 nF, Li < 10 µH. M20 x 1.5 conduit entry. Temperature range: T4: -40° to +85 °C / -40° to +185 °F T5: < +75 °C / +167 °F ; T6: < +60 °C / +140 °F
E1	Flameproof enclosure, M20 x 1.5 conduit entry. **ATEX certifications:** II 2 G Ex d IIC T4...T6 (EN 60079-0:2006, EN 60079-1:2004) II 2 D Ex tD A21 IP66 T100 °C (EN 61241-0:2006, EN 61241-1:2004) **ND93_PE1:** Ui ≤ 32 V Temperature range: T4; -40° to +85 °C / -40° to +185 °F T5; < +75 °C / < +167 °F, T6; < +60 °C / < +140 °F
E5	Flameproof enclosure, 1/2 NPT conduit entry. Temperature range: -40° to +85 °C / -40° to +185 °F. **INMETRO certifications:** BR-Ex d IIC, T4/T5/T6, IP66 (IEC 60079-0/00, IEC 60079-1/01, NBR 9518/97, NBR 5363/98, IEC 60529/01) **ND93_PE5:** Ui ≤ 32 V Temperature range: T4: -40° to +85 °C / -40° to +185 °F T5: < +75 °C / < +167 °F ; T6: < +60 °C / < +140 °F

7.	**OPTIONS OF VALVE CONTROLLER**
G	Exhaust adapter. 1 x 1/2 NPT thread. Not available with 7. sign M.
Y	Special construction, to be specified.

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