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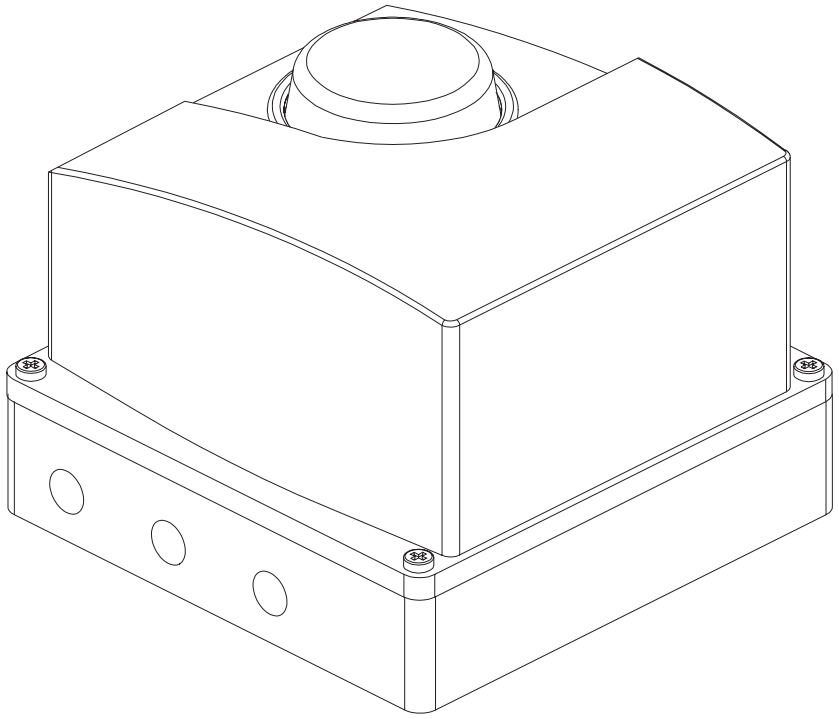


VALVE CONTROLLER

ND800PA

Rev. 1.0

Installation, Maintenance and
Operating Instructions
7 ND 72 en
4/02

metso
automation

Table of Contents

READ THESE INSTRUCTIONS FIRST!

These instructions provide information about safe handling and operation of the 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 INTRODUCTION

1.1 General

These instructions describe the digital Metso Automation ND800PA valve position controller. The ND800PA can be used with either cylinder or diaphragm type pneumatic actuators for rotary or linear valves.

1.2 Principle of operation

The ND800PA is a fieldbus powered microcontroller-based valve controller. The ND800PA configuration can be done either using local push buttons, Simatic PDM (Process Device Manager) or some other suitable Profibus PA configurator.

Using push buttons or PDM the configuration parameters can be set according to the actuator and valve in question. Then auto-calibration can be started via push buttons or PDM. A three-digit display with text labels describes the operation.

In control service the microcontroller (µC) reads data from the input signal (Profibus PA), position sensor (α) and pressure sensor (p). A change in input signal will be detected by control algorithm inside the µC. The microcontroller will change the pilot current to one of the prestage (PR) coils. A prestage valve lowers the pilot pressure at the end of the spool valve (SV). The spool moves in the direction of low pressure to open the flow in to the top of the actuator cylinder and out from the other side of the piston. The increasing pressure difference over the piston moves the piston and rotates the feedback shaft. A position sensor (a) measures the rotation for the µC. Using a control algorithm the microcontroller adjusts the pilot current until a new position of the actuator proportional to the input signal is reached. In the steady state, the spool valve (SV) and prestage (PR) valves are closed.

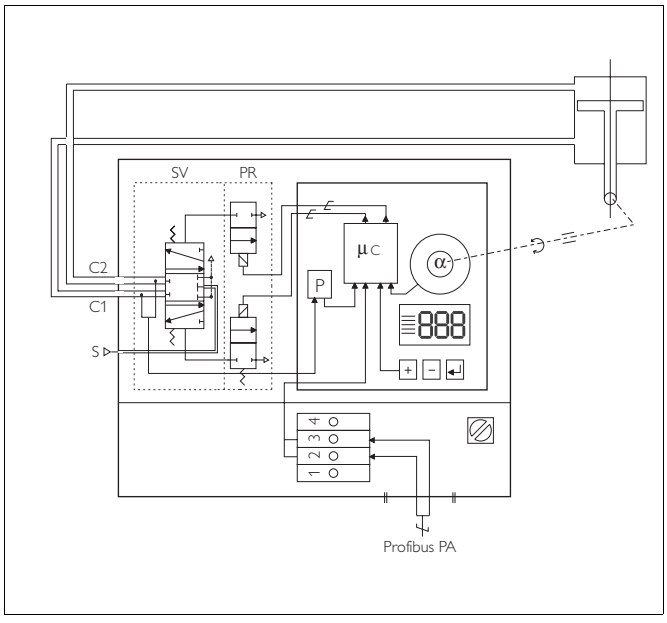


Fig. 1. Schematic diagram

1.3 Markings

The valve controller is equipped with an identification plate sticker (Fig. 2). Identification plate markings from top to bottom are:

- ☐ Type designation of the valve controller
- ☐ Revision number
- ☐ Enclosure class
- ☐ Input signal
- ☐ Maximum supply voltage
- ☐ Supply pressure range
- ☐ Operational temperature
- ☐ Manufacturing series numbers
- ☐ CE mark

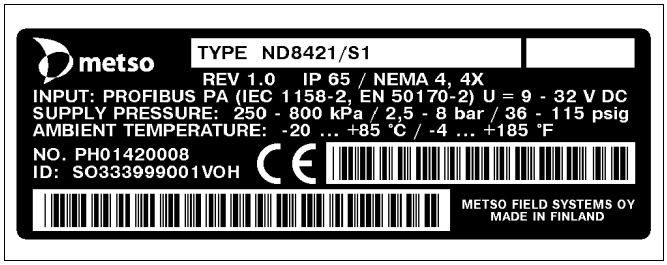


Fig. 2. Identification plate

Alternative markings on the optional plate (Fig. 3):

- ☐ Filter-regulator (-K)
  Operational temperature of regulator
- ☐ Conduit entries (-L, -I or -NJ)

Fig. 3. Optional plate

1.4 Technical specifications

General

The ND800PA valve controller is suitable for rotary and sliding stem valves.

Actuator connection	In accordance with VDI/VDE 3845 standard (S1) or as an option compatibility with other NE-series (S2). To replace an existing NE/NP positioner, specify existing valve assembly
Action:	Double or single acting
Turning angle:	min 60°, max 95°

Environmental influence

Operational temp.:	-20 - +85 °C (-4 - +185 °F)
option	-40 - +85 °C (-40 - +185 °F)
Influence of temperature on valve position	< 0.05 % / °C
Influence of vibration on valve position	< 1 % under 2g 5-150 Hz and 1g 150-300 Hz 0.5g 300-2000 Hz

Enclosure

Material:	Anodized aluminium alloy
Protection class:	IP65, NEMA 4 and 4X
Mechanical position indicator:	on cover
Pneumatics ports:	1/4 NPT
Electrical connection:	Screw terminals internals for 2.5 mm^2 and 1 PG 13.5 conduit entry (1/2 NPT, M20x1.5 and R 1/2 as option, see optional plate)
Weight:	2.1 kg (4.6 lbs)

Pneumatics

Supply pressure:	2.5-8 bar (36-115 psi)
Effect of supply pressure:	< 0.2 %/10 kPa (0.14%/psi)
Air quality:	As defined by ISA S7.3 standard
Capacity:	Max 30 Nm^3/h (18 scfm) at 4 bar (60 psi) supply
Consumption:	0.4 Nm^3/h (0.24 scfm) at 4 bar (60 psi) supply

Electronics

Power supply:	Taken from bus
Bus voltage:	9 to 32 VDC Reverse polarity protection permits connection of the bus cables in any order
Typical operating current at 24 V supply voltage:	21.8 mA
Operating current over full ambient temperature and supply voltage range:	20.1-23.45 mA
Max. current in Failure (FDE Current):	27.0 mA

Performance with moderate constant load actuators

Hysteresis + dead band:	< 1 %
Linearity error:	< 2%

Local keypad functions

Calibration:	Automatic / Manual
Control feedback:	0.0-3.0 (d and b)
Gain configuration:	0.1-3.0 (gain)
Mode Selection:	Auto/Man/Off
Positioner Fail Action, PFA:	- close (default) - open
Position Sensor Rotation, ROT:	- clockwise (default) - counterclockwise
Dead Angle Compensation, A0:	acc. to valve (0 % default)
Valve Type Selection, TYP:	- rot (rotary valve), default - lin (linear valve)
Setpoint Cut-off CLOSE, CLO:	- 0-100 % (2 % default)
Setpoint Cut-off OPEN, CHI:	- 0-100 % (100 % default)
Lower Limit Valve Position, RLO:	- 0-100 % (0 % default)
Upper Limit Valve Position, RHI:	- 0-100 % (100 % default)
Profibus slave address, ADR:	- 0-126, default 126

Electrical connections

Input signal:	Profibus PA according to IEC 61158-2

Approvals

Temp. ≤ +75 °C (+67 °F):
Cenelec EEx ia IIC T5/T6 (pending),
Temp. ≤ +50 °C (+122 °F):
CSA Class I, Divisions 1 and 2,
Groups A, B, C and D (pending)
FM Class I, Divisions 1 and 2,
Groups A, B, C and D (pending)

Sensors

Position sensor linear range:	110 °
Actuator pressure sensor linear range:	7 bar (100 psi) (differential pressure)

User interfaces

Local:	3 keys + LCD display

Simatic PDM functions:

Flow characterization:	Linear, equal percentage, quick opening, custom
Identification information:	HW/SW rev., serial numbers, actuator type etc.
Monitoring:	Valve travel setpoint, actual travel, actuator pressure and device temperature
Diagnostics:	Travel deviation, travel duration, load factor, operation time, valve/actuator travel counters, failure information
Testing:	Step response, hysteresis loop
Module calibration:	Position sensor, pressure sensor, temperature measurement

Electromagnetic protection

Protection standards:	EN50081-1 and EN50082-2 IEC 801-2 ESD, level 4, IEC 801-3 Electro Magnetic Field, level 3 IEC 801-4 Fast Transients, level 4

CE marking

Electromagnetic compatibility:	89/336/EEC

1.5 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, spool valve or pressure sensor of an ND800PA 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.

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

EXi CAUTION:
Make sure that the complete installation and wiring is intrinsic safe before operating the device!

EXi CAUTION:
Make sure that that the power source (e.g. segment coupler, link or fieldbus power supply) is EXi certified apparatus!

EXi CAUTION:
Make sure that all the devices which are connected to the fieldbus segment are EXi certified devices!

EXi CAUTION:
Do not remove the protective cover within hazardous area!

EXi NOTE (FM):
The installation must be in accordance with the FM Control drawing. See 13.1 FM Control drawing.

EXi NOTE (CSA):
The installation must be in accordance with the CSA Control drawing. See 13.2 CSA Control drawing.

NOTE:
Avoid earthing a welding machine in close proximity to an ND800PA valve controller.
Damage to the equipment may result.

2 MOUNTING

2.1 General

NOTE:
The mounting must be in accordance with the installation guidelines IEC-EN 60079-10.

If the ND800PA is supplied with valve and actuator the tubes are mounted and the ND800PA adjusted in accordance with the customer's specificatons. If the controller is ordered separately, the mounting parts for the assembly must be ordered at the same time.

Sample order: (B1C13)-Z-ND826/S1.

The controller is equipped with both the new Metso Automation mounting face, for connection according to VDI/VDE 3845 (S1), The mounting code for EC and EJ actuators is S4.

Shaft alternatives for the controller for Metso Automation rotary actuators are shown in Fig. 4.

For mounting parts for Metso Automation actuators, see Sections 10.2-10.6.

2.2 Mounting on Metso Automation actuators with VDI/VDE mounting face (S1)

See Sections 10.2, 10.4

- ☐ Run the actuator until the piston is in the top position (spring return actuators in the position determined by the spring).
- ☐ Set the direction arrow in the direction of the valve closure member and attach the draught piece (2) to the indicator cover in the position shown in Fig. 4. Secure the screw of the draught piece e.g. with Loctite and tighten it sufficiently.
- ☐ Attach the bracket (1) to the ND800PA.
- ☐ Attach the bracket (1) to the actuator. The shaft (40) of the ND800PA must fit into the draught piece (2) shown in Fig. 4. See also drawings in Section 10.2.

Note the differences in installation between the B1C, B1J and B1JA actuators.

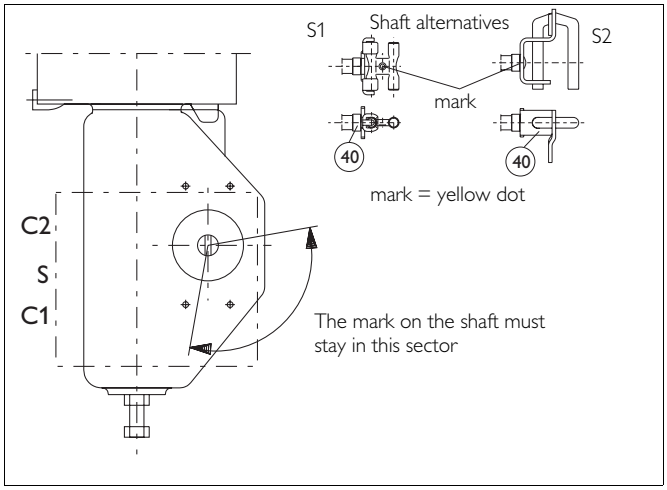


Fig. 4. Mounting on Metso Automation actuator with VDI/VDE mounting face

2.3 Mounting on EC and EJ actuators (S4)

See Sections 11.6-11.9

- ☐ Mount the O-rings (38) into the air connections in the bottom of the controller.
- ☐ Place the valve controller on top of the actuator so that the yellow mark is located in the position shown in Fig. 5. See also Fig. 15.
- ☐ Fasten the screws (4). Two of the screws are located at the front edge and two inside the controller housing.

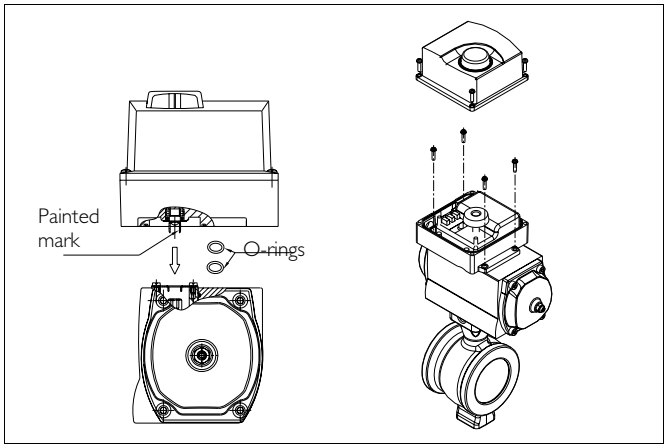


Fig. 5. Mounting on EC and EJ actuators

Table 1. Piping

Actuator			Piping						Spool valve
			Plastic/Cu/SS (")			Plastic/Cu/SS (mm)			
B1C	Stroke vol. dm^3/in^3	NPT	1/4	3/8	1/2	6/4	10/8	12/10	
6	0.3/18	1/4	×			×			2
9	0.6/37	1/4	×			×			2
11	1.1/67	3/8	×			×			2
13	2.3/140	3/8		×			×		6
17	4.3/262	1/2		×			×		6
20	5.4/330			×			×		6
25	10.5/610	1/2		×	(×)		×	(×)	6
32	21/1282	3/4		×	(×)		×	(×)	6
40	43/2624	3/4		(×)	×			×	6
50	84/5126	1		(×)	×			×	6
502	195/11900	1			×			×	6
B1J B1JA	Stroke vol. dm^3/in^3	NPT	1/4	3/8	1/2	6/4	10/8	12/10	Spool valve
8	0.9/55	3/8	×			×			21
10	1.8/110			×			×		61
12	3.6/220	1/2		×			×		61
16	6.7/409			×			×		61
20	13/793	3/4		×	(×)		×	(×)	61
25	27/1648			×	(×)		×	(×)	61
32	53/3234	1		(×)	×			×	61
322	106/6468				×			×	61
QP	Stroke vol. dm^3/in^3	NPT	1/4	3/8	1/2	6/4	10/8	12/10	Spool valve
1	0.62/37	3/8	×			×			21
2	1.08/66	3/8	×			×			21
3	2.18/133	3/8		×			×		61
4	4.34/265	3/8		×			×		61
5	8.7/531	3/8		×			×		61
6	17.5/1068	3/4			×			×	61
EC	Stroke vol. dm^3	G							Spool valve
05	0.09	1/4	N/A	N/A	N/A	N/A	N/A	N/A	1
07	0.2	1/4	N/A	N/A	N/A	N/A	N/A	N/A	1
10	0.5	1/4	N/A	N/A	N/A	N/A	N/A	N/A	2
12	1.2	1/4	N/A	N/A	N/A	N/A	N/A	N/A	2
14	3.0	1/4	N/A	N/A	N/A	N/A	N/A	N/A	6
EJ	Stroke vol. dm^3	G							Spool valve
05	0.18	1/4	N/A	N/A	N/A	N/A	N/A	N/A	11
07	0.4	1/4	N/A	N/A	N/A	N/A	N/A	N/A	21
10	1	1/4	N/A	N/A	N/A	N/A	N/A	N/A	21
12	2.4	1/4	N/A	N/A	N/A	N/A	N/A	N/A	61
14	6	1/4	N/A	N/A	N/A	N/A	N/A	N/A	61

Table 2. Spring rates

Actuator type	Spring rate (bar/psi)
B1JK	3/43
B1JSTD	4.2/61
B1JV	5.5/80
QPB	3/43
QPC	4.3/62
QPD	5.6/81
Adjust regulator pressure to a level which is max 1 bar (14.5 psi) + spring rate. If spring rate is less than 3 bar (43 psi) then supply pressure 4 bar (58 psi) is recommended.	

2.4 Mounting on linear actuators with Metso Automation or IEC 60534 mounting face

See Sections 10.5, 10.6.

- ☐ Connect an airset directly to the actuator and position the actuator at its mid-stroke position (see serial plate for actuator stroke length).
- ☐ Attach the feedback arm on to the controller input shaft. Make sure the lettering on the feedback arm faces up, toward the controller.
- ☐ Attach the controller mounting bracket loosely on to the slotted leg of the actuator. Make sure the marks on the shaft and feedback arm operate in the quadrant shown.
- ☐ Measure the distance from the centre of the feedback lever shaft to the slot on the feedback lever and mark this distance with a pencil or other marking instrument. Use the dimensions given in Sections 10.5 and 10.6.
- ☐ Mount the controller loosely onto the controller mounting bracket.
- ☐ Adjust the controller mounting bracket and the controller so that the controller is at 90° to the centre line of the actuator and the controller feedback lever is horizontal and at 90° to the centre line of the actuator.
- ☐ Tighten the controller mounting bracket screws.
- ☐ Adjust the controller on the controller mounting bracket so that the measured distance is maintained between the centre of the feedback lever shaft and the actuator pin (pre-measured mark on the feedback lever). Note the controller must still conform to the specifications in previous steps.
- ☐ Tighten all the mounting bolts and then re-check that the controller complies with previous steps. Check that the actuator pin does not touch the controller case throughout the entire stroke of the actuator. If the actuator pin is too long it may be trimmed to length. (The pin must be trimmed on stroke of 1.125" or less.)
- ☐ Attach the spring on to the feedback arm as shown.
- ☐ Apply grease (Molykote or equivalent) to the contact surfaces of the actuator pin and the feedback lever to reduce wear.
- ☐ Increase and/or decrease air pressure to the actuator to stroke the actuator full stroke to check that nothing is binding and that the rotation of the feedback lever is 70° for a 1"-5" stroke and 60° for a ¾" stroke. See Sections 10.5 and 10.6.

2.5 Piping of supply air

CAUTION:
Do not exceed the permitted supply pressure of the ND800PA!

Table 1 provides the recommended tube sizes in accordance with actuator sizes. Tube sizes are the minimum values allowed. For supply air choose a tube one size bigger. Operating times can be tested by the PDM.

Connect the air supply to S (1/4 NPT).
Connect C1 and C2 (1/4 NPT) to the actuator.

For the pipe threads liquid sealants, such as Loctite 577, are recommended.

NOTE:
Too much sealant may cause faulty operation of the controller.
Sealing tape is not recommended.
Ensure the cleaniness of the air piping.

The supply air must be clean, dry and oil-free instrument air, e.g. according to standard ISA S7.3-81.

2.6 Electrical connections

The bus cable is led through a PG13,5 cable gland. Connect the conductors to the terminal strip according to Fig. 6.

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

Depending on the plant grounding policy, either Equipotential Bonding or Capacitive grounding can be used. See "PROFIBUS - PA User and Installation Guideline". In the case of Equipotential Bonding, connect the cable shield to earth connection screw. In the case of Capacitive grounding, connect the cable shield to terminal strip 1.

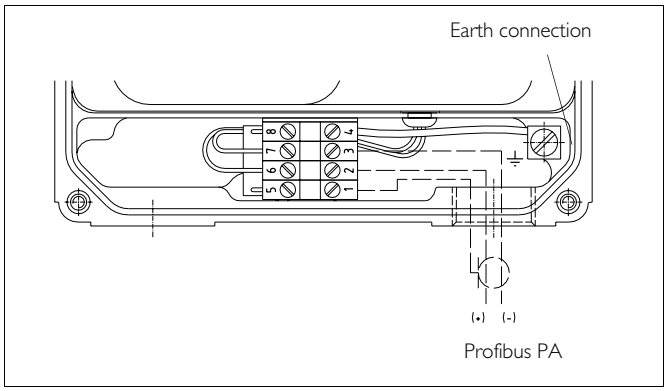
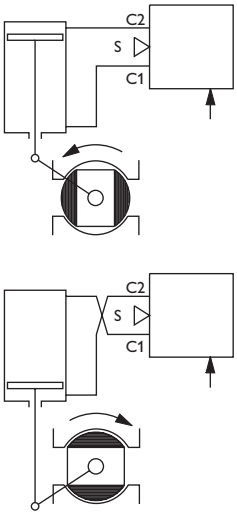


Fig. 6. Terminals



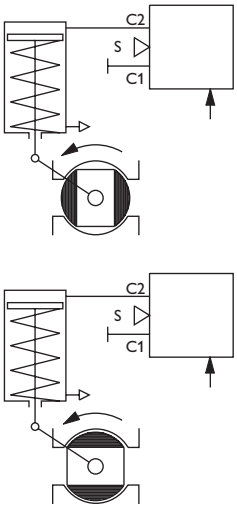
DOUBLE-ACTING ACTUATOR

1. Self closing.

   Default setting:
   PFA = CLO
   ROT = cC (close valve to clockwise)
   A0 = % (acc. to valve type)
   cLo = 2 %
   NOTE: EC05 actuator requires a coupling plate

2. Self opening.

   Setting:
   PFA = OPE
   ROT = cC (close valve to clockwise)
   A0 = % (acc. to valve type)
   cLo = 2 %
   NOTE: EC07...EC14 actuators require external piping
   EC05 actuator requires a coupling plate (reverse action)



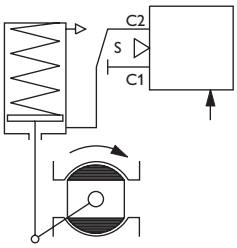
SINGLE-ACTING ACTUATOR (SPRING TO CLOSE)

3. Self closing.
   Spring to close valve.

   Default setting:
   PFA = CLO
   ROT = cC (close valve to clockwise)
   A0 = % (acc. to valve type)
   cLo = 2 %

4. Self opening
   Spring to open valve.

   Setting:
   PFA = OPE
   ROT = ccC (close valve to counterclockwise)
   A0 = % (acc. to valve type)
   cLo = 2 %
   CAUTION: Valve closes exceptionally counterclockwise.
   Unsuitable for Q-, R-, T5-, F- and L-series valves.



SINGLE-ACTING ACTUATOR (SPRING TO OPEN)

5. Self opening.
   Spring to open valve.

   Setting:
   PFA = OPE
   ROT = cC (close valve to clockwise)
   A0 = % (acc. to valve type)
   cLo = 2 %

After self-tuning the default parameters are as follows:

Gain	= 1.0	(for enhanced control use Gain=1.2)
d	= 0.0	for double acting actuators (factory set)
d	= 1.0	for single acting actuators (factory set)
b	= 1.0	

In order to achieve symmetrical operation, always use filter regulator in connection with spring return actuators. See Table 2.
RA and DA actuators: use spool 21A. RB, RC, RD, RE and DB, DC, DE actuators: use spool 61A.
NOTE: Use QP values for diapharagm-pneumatic linear actuators.
Use B1J values for spring-return cylinder actuators. Use B1C values for double-acting cylinder actuators

If operational conditions change considerably, perform self-tuning for optimum performance.

Fig. 7. Operation directions and air connections

3 USER INTERFACE

3.1 Keyboard and display

The keyboard and the display of the ND800PA are shown in Fig. 8. Only applicable information is shown on the display in each mode. Operations and display are controlled by +, – and ↵ keys.

Four setting functions are available: **MODE:**, **GAIN**, **DB** or **CALIB**. Each of these names refers to the function to be adjusted or changed.

In **AUT●** or **MAN** mode the display indicates 0-100 % as the valve travel. In **OFF** mode the display shows two dashes (--) instead of digits. By pressing the ↵ key the display shows the analog output block output value (A0.OUT) within about 5 seconds. In other situations the display indicates the adjustable parameter value selected.

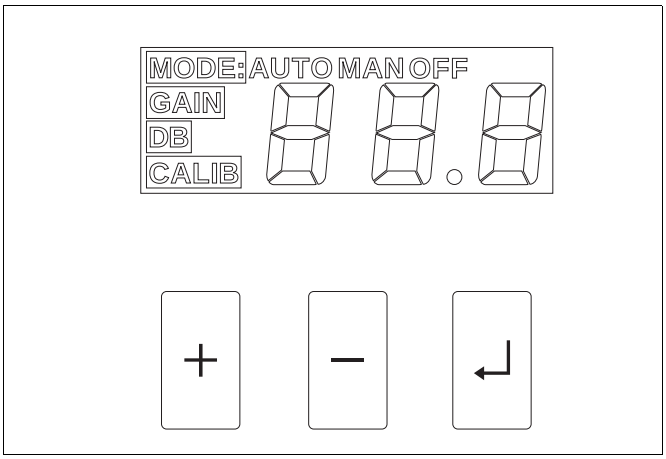


Fig. 8. LCD-display and keyboard

3.2 Keyboard functions

See keyboard operations (Fig. 11).

The keyboard setting state is initiated by pressing the + and – keys for 5 seconds. The blinking text item **MODE:** and one of the previously selected operation modes, **AUT●**, **MAN** or **OFF**, will be shown on the display. If you want to change the operation mode, press ↵ first. **AUT●**, **MAN** or **OFF** will start to blink showing that the mode-changing function is enabled. Choose the desired mode, **AUT●**, **MAN** or **OFF**with the + or – key. After the mode has been selected, press the ↵ key.

The **MODE:** function provides three alternative ND800PA operation modes:

AUT●:
During **AUT●** mode the ND800PA controls the valve position according to the analog output block (AO) output signal. This mode is used during normal process control service.

MAN:
During this mode the valve position can be manually controlled from the keyboard + or – keys. The position of the manually driven valve is not saved in the non-volatile memory of the ND800PA, i.e. the valve does not return to the same position after power failure. However, the valve can be driven back into position after power failure by the + and – keys.

OFF:
When the **OFF** mode is activated the ND800PA closes the valve and does not respond to incoming signal.

Accept the selected mode by pressing the ↵ key which returns you automatically to the setting state.

Move to the next setting by pressing the + key. **GAIN** starts to flash. The positioner gain required for different size of actuators is set with the **GAIN** parameter. **GAIN** is set automatically by self-tuning procedure during **AUT●**/ **MAN** calibration. Pressing the ↵ key allows you to change the gain value shown on the display with the + and – keys. Accept a changed value with ↵ key, which returns you automatically to the setting state.

DB includes positioner feedback parameters *d* and *b*. By pressing the ↵ key you can select one of the above parameters with the + and – keys. Confirm your choice with the ↵ key and change values with + and – keys. Confirm the value with ↵. Default values are listed in Fig. 7.

The next setting to move to with the + key is **CALIB**. By pressing the ↵ key you can start zero and travel range calibration and self-tuning. More detailed information about **CALIB** is given in Section 4.1.

Within different options you can move forward with the + key and with the – key backward.

In addition, there are nine control valve related configuration parameters: *PFA*, *rot*, *A0*, *HYP*, *dL0*, *ch1*, *rLo*, *rh1* and *Adr* which are explained in Section 4.3

You can return to the operation state from any setting by pressing + and – keys simultaneously for less than 1 second, repeating if necessary.

3.3 HW write protection

The ND800PA 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 a switch (DIP1) located on the circuit board (Fig. 9). DIP2 is not in use.

Write protection protects all acyclic write access to all writeable parameters of the device. Changing the parameters from the local keyboard or PDM is thus not allowed.

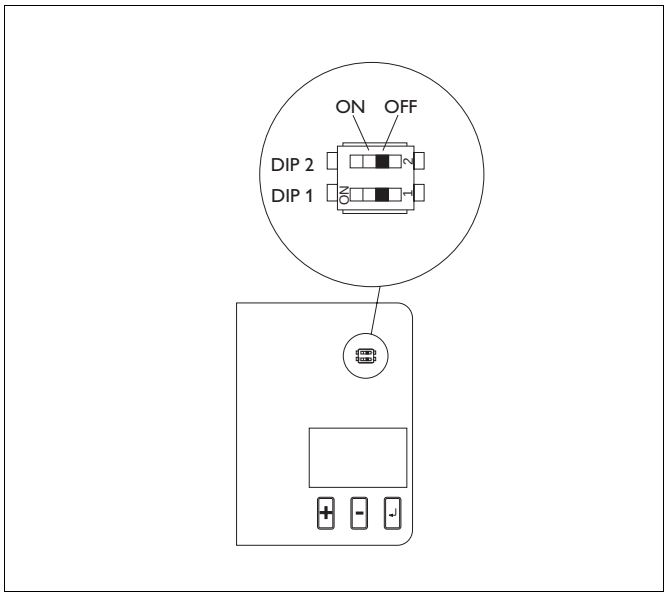


Fig. 9. DIP switch

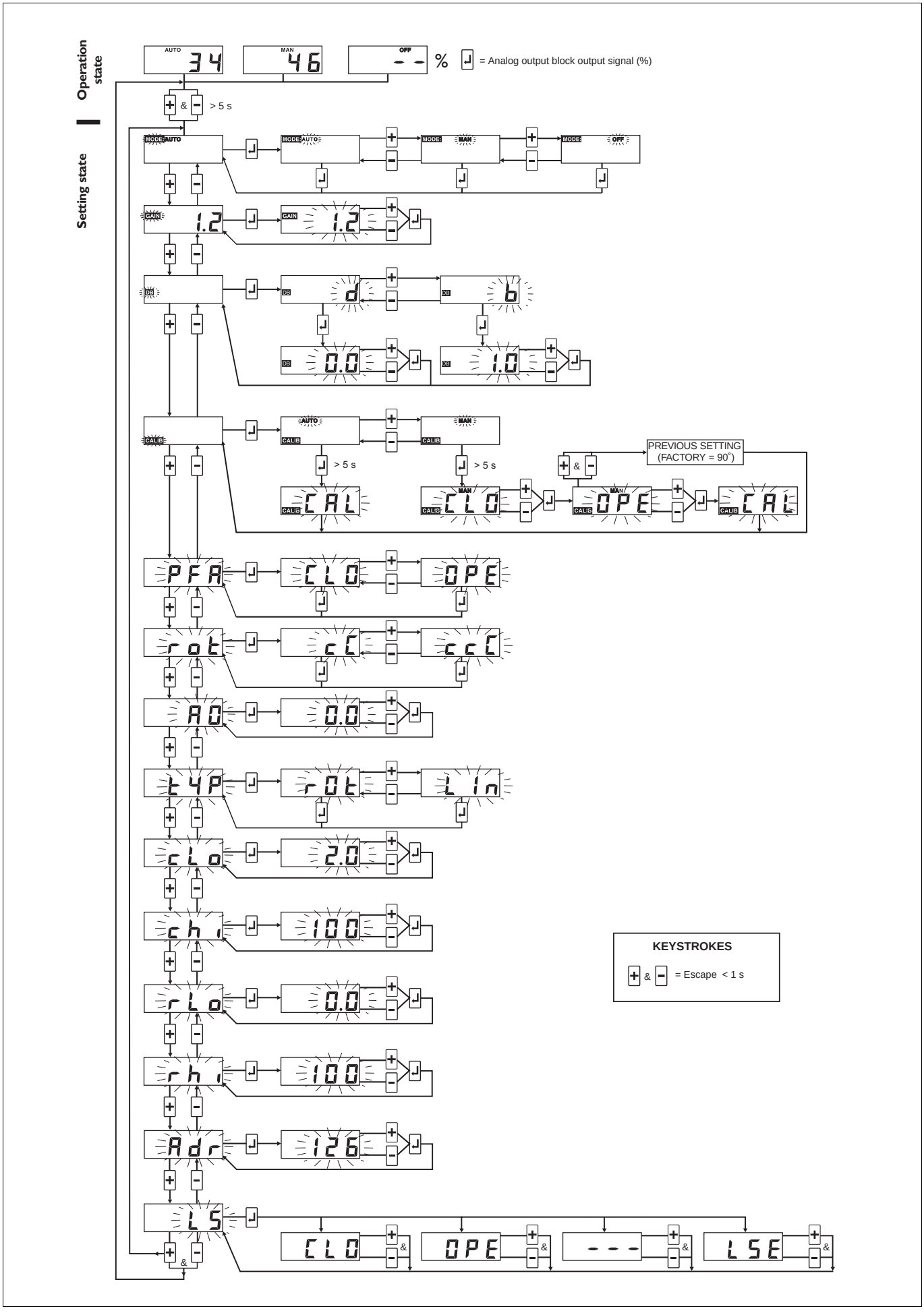


Fig. 10. Keyboard operations

4 CONFIGURATION

4.1 Zero and range

The ND800PA position sensor operational range is factory adjusted to suit Metso Automation actuators. If the ND800PA is to be fitted into another manufacturer's actuator, the sensor may need to be readjusted as explained in Section 5.4.

- ☐ Connect the air supply and fieldbus cable.
- ☐ Select the **CALIB** function from the keyboard according to 3.2.
- ☐ Now you can select the **AUT●** or **MAN** calibration mode from the display by pressing the + or − key.

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

Self-tuning procedure:

- ☐ This is performed automatically during **AUT●** or **MAN** calibration.
- ☐ As a result of self-tuning the **GAIN** is set = 1 and *b* is set = 1.
- ☐ *d* is originally factory set as explained in Fig. 7.

AUT● calibration function:

- ☐ For safety reasons the ↵ key needs to be pressed for 5 seconds to activate the **AUT●** calibration function. During calibration the display shows the text *CAL*. After calibration the ND800PA returns automatically to the setting function.
- ☐ A self-tuning procedure is performed.
- ☐ At any time you may interrupt the calibration sequences by pressing the + and − keys simultaneously.
- ☐ After the **AUT●** calibration sequence is finished press the + and − keys simultaneously to get back to the operation state. If this sequence has ended and an error message *Err* appears on the display, see Chapter 6.

Now the ND800PA will work with basic settings including 2 ± 0.5 % signal cutoff margins to secure full closing of the valve.

If you cannot drive the valve into a fully open position or if there is no mechanical limit stop, proceed as follows:

MAN calibration function:

- ☐ After selecting the **MAN** calibration function from the display 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 cannot drive the valve into the open position, you may skip this sequence by pressing the + and − keys simultaneously. Now the ND800PA assumes that the maximum valve opening is the latest calibrated value. The factory setting is 90°.
- ☐ Drive the valve into the desired maximum opening position (100 %) with the + and − keys and press the ↵ key.
- ☐ A self-tuning procedure is performed.
- ☐ If an error message *Err* appears on the display, see Chapter 7.
- ☐ Press the + and − keys simultaneously to return to the operation state.

Now the valve controller will work with basic settings including 2 ± 0.5 % signal cutoff margins.

4.2 Position control

GAIN is the gain parameter, *d* is the actuator pressure feedback parameter and *b* is the valve velocity feedback parameter. The default values after self-tuning are given in Fig. 7. Values are defined for the control valve in question during self-tuning. However, because of the large range of pressure drop and temperature for the different processes, variations in supply air pressure and the great variety of valve constructions, actuator load may differ considerably from the default value. For this reason **GAIN**, *d* and *b* may have to be adjusted to ensure optimum control performance for special cases. Use the following guidelines to adjust **GAIN**, *d* and *b*.

- ☐ Check that *d* value is according to Fig. 7.
- ☐ Perform **AUT●** or **MAN** calibration.
- ☐ For enhanced control increase the **GAIN** to value 1.2
- ☐ If the valve is unstable, lower **GAIN** until the valve is stable at a constant input signal. If higher **GAIN** is needed, increase *d* to dampen instability with spring-return actuators.
- ☐ If the valve is slow, increase **GAIN**. If the valve is overshooting, decrease **GAIN**. Adjust **GAIN** for slight overshooting and then increase *b* to dampen it.
- ☐ If the deviation between input signal and actual valve position is high, increase **GAIN** to decrease deviation. However, avoid unstable operation.

GAIN setting:

- ☐ Select the **GAIN** function from the keyboard according to Section 3.2.
- ☐ Now the display should indicate the current parameter value. If you want to change it, press the ↵ key.
- ☐ Increase the parameter value by pressing the + key or decrease its value by pressing the − key.
- ☐ Press the ↵ key when the desired value appears on the display.
- ☐ Press the + and − keys simultaneously to return to the operation state.

DB setting:

- ☐ The **DB** parameters can be adjusted in the same manner. (See Fig. 10).

The ND800PA stays in the selected operation mode during the **GAIN** and **DB** settings.

4.3 Control valve related settings

The basic factory settings of the ND800PA assume a positioner fail action to be closing the valve and a clockwise closing direction for the position sensor. The setpoint cut-off CLOSE is set to 2 ± 0.5 % to guarantee full closing of the valve against mechanical travel stops.

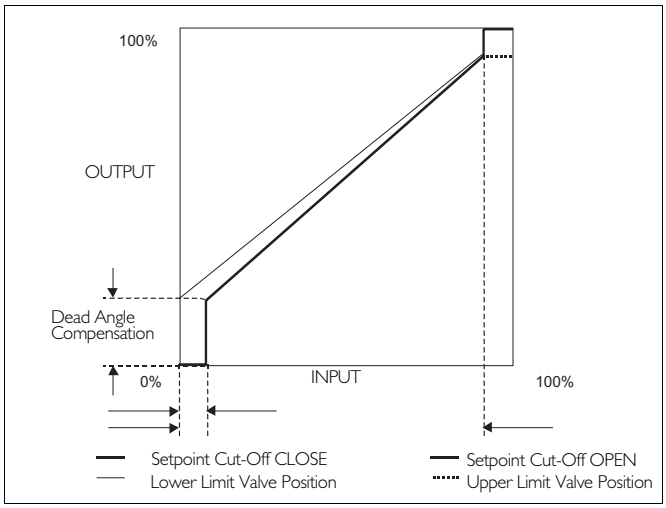


Fig. 11. The input signal modifications accomplished using Dead Angle compensation, Cut-Off and Limit functions

Following parameters are possible to change during setting state by pressing + or − keys until the parameter in question appears on the display.

Positioner fail action (PFA)

Configuration of the action taken during the **loss of the power** (supply pressure is available). This action takes place **also** when the positioner software notices a fatal device failure. In these both cases the spool valve feeds C1 and releases C2 pressure, see Fig. 7.

- ☐ When the letters PFA appear on the display you may read the current value by first pressing the ↵ key and then selecting either the CLO or OPE values by pressing the + and − keys.
- ☐ To conclude press the ↵ key when the desired value is shown on the display. See default values in Fig. 7 and functions in Fig. 10.

Position sensor rotation (roA)

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

- ☐ Once roA is displayed press the ↵ key and the current parameter value will be shown on the display. Now you may select between two values by pressing the + or − key. The value CW means clockwise rotation for closing the valve and CCW means counterclockwise to close.
- ☐ After the desired value is displayed, press the key ↵ to conclude the operation. See default values and tubing sizes in Fig. 7 and functions in Fig. 10.

α_0 setting (dead angle, AD)

The α_0 setting is made for Metso Automation 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 (Figure 12 and Table 3). Use 0 % as the "dead angle" for the valves not mentioned in Table 3.

- ☐ After selecting AD on the display, press the ↵ key and the parameter value currently selected appears as a percentage (%) on the display.

Table 3. Dead angle as percentage

Valve size		Valve series							
		MBV QMBV 1)	MBV QMBV 2)	D 3)	T5, QT5	QX-T5	T25, QT25	QX-T25	R, QR
mm	in	Dead angle as %							
25	1	14	-	-	25.5	19.5	-	-	15
40	1 ½	12	-	-	24.5	12.5	-	-	12
50	2	10	9	13.5	24.5	12.5	18.0	8.0	17
65	2 ½	9	-	-	-	-	-	-	13
80	3	10	8	12.0	18.0	8.0	16.5	8.5	9
100	4	10	8	12.0	16.5	8.5	16.0	9.0	8
125	5	12	-	-	-	-	12.0	6.5	8
150	6	10	8	11.5	16.0	9.0	13.5		8
200	8	9	7	8.5	12.0	6.5	9.5		7
250	10	9	7	7.5	13.5		9.5		7
300	12	8	6	6.5	9.5		7.5		6
350	14		6	6.0	-				5
400	16		5	5.5	95(14")				5
450	18			6.0	75(16")				
500	20			6.0					
600	24			5.5					
650	26			7.0					
700	28			7.0					
750	30			6.0					
800	32			-					
900	36			5.5					

1) Seat supported 2) Trunnion 3) S/G seat

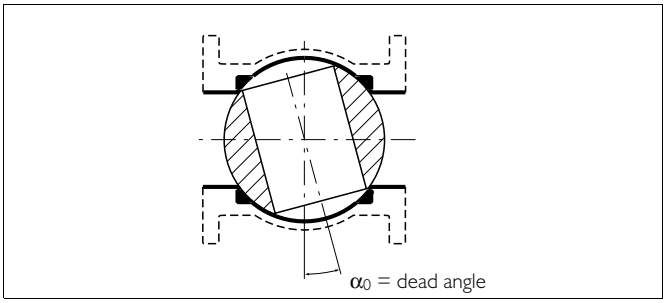


Fig. 12. Dead angle

- ☐ Modify the parameter value by pressing + or − keys alternately until the desired value appears on the display.
- ☐ Press the ↵ key to finalize your selection and return to the setting state. See Fig. 10 for functions.

Valve type selection (HYP)

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 at the HYP display.

- ☐ After selecting HYP on the display, press the ↵ key and select between two values rot and Lin using the + and – keys. The value rot indicates a rotary valve and Lin a linear valve.
- ☐ To conclude press the ↵ key when the desired value is shown on the display.

Setpoint cut-off CLOSE (cLo)

- ☐ When cLo appears on the display, press the ↵ key and the current default value as a percentage (%) appears on the display. The Metso Automation' standard default value is 2 % (2.0). Now modify this value to the desired number and press the ↵ key to return to the setting state. See Fig. 10 for functions.
- ☐ When input signal goes below the defined value, the valve is driven to the CLOSED position, see Fig. 11.

Setpoint cut-off OPEN (chi)

- ☐ When chi appears on the display, press the ↵ key and the current default value as a percentage (%) appears on the display. The Metso Automation's standard default value is 100 % (100). Now modify this value to the desired number and press the ↵ key to return to the setting state. See Fig. 10 for functions.
- ☐ When input signal goes above the defined value, the valve is driven to the OPEN position, see Fig. 11.

Lower limit valve position (rLo)

- ☐ When rLo appears on the display, press the ↵ key and the current default value as a percentage (%) appears on the display. The Metso Automation's standard default value is 0 % (0.0). Now modify this value to the desired number and press the ↵ key to return to the setting state. See Fig. 10 for functions.
- ☐ Valve position is never allowed to go below this value. The only exception is fail-safe situation. See Fig. 11.

Upper limit valve position (rhi)

- ☐ When rhi appears on the display, press the ↵ key and the current default value as a percentage (%) appears on the display. The Metso Automation's standard default value is 100 % (100). Now modify this value to the desired number and press the ↵ key to return to the setting state. See Fig. 10 for functions.
- ☐ Valve position is never allowed to go above this value. The only exception is fail-safe situation. See Fig. 11.

NOTE:
The setpoint cut-off function overrides the limit function. If setpoint cut-off CLOSE is greater than 0 %, the lower limit Valve position is not applied (has value 0 %). Correspondingly, if setpoint cut-off OPEN is smaller than 100 %, the upper limit valve position is not applied (has value of 100 %).

Profibus slave address, (Adr)

- ☐ When Adr appears on the display, press ↵ key and the current value appears on the display. The default is 126. Now modify this value to desired number and press ↵ key to return to the setting state. see Fig. 10 for instructions.
- ☐ When all the control valve-related parameters are correctly set, return to operation state by pressing the + and – key simultaneously for a short time.

5 MAINTENANCE

The maintenance requirements of the ND800PA valve controller depend on the service conditions, for instance, the quality of instrument air. In normal service conditions no regular maintenance is required.

The best reliability is achieved by following these instructions.

In the following text the numbers in parenthesis ( ) correspond to the part numbers on the expoded view in Chapter 11, unless otherwise stated.

The ND800PA valve controller includes the following interchangeable modules: prestage (3), spool valve (4), circuit board pack (5), position sensor (6), and differential pressure sensor (7).

The modules are located underneath a protective cover (46) which is attached with M3-screws (48, 4 pcs.). If a module fails it must be changed. The module retrofit must be made in a clean, dry environment. After replacement apply thread-locking compound (for instance, Loctite 243) and tighten the screws firmly.

5.1 Prestage

NOTE:
The prestage must be handled very carefully. In particular the moving parts on both ends of the prestage should not be touched when the prestage is functioning and the protective cover is not in place.

Disassembly

- ☐ Unplug the prestage (3) wire connectors from the circuit board (5). Unscrew the M4 screws (92, 2 pcs.) and remove the prestage module.

Reassembly

- ☐ Place the O-rings (91) in the respective grooves and press the prestage into place. Make sure that the nozzles are properly guided on top of the O-rings. The screws guide the prestage body into the correct position.
- ☐ Push the prestage 2-pole wire connectors into the sockets on the circuit board. Make sure that the wires do not cross each other. The wire connectors can only be fitted in the correct way.
- ☐ Tighten the screws (92) evenly with a torque of approx. 0.8 Nm (0.6 ft.lb).
- ☐ Set the protective cover (46) carefully in place and tighten the screws (48).

5.2 Spool valve

Before removing the spool valve (4) the prestage (3) must be taken off. (See Section 5.1)

Disassembly

- ☐ Unscrew the M4 screws (99, 4 pcs.) and remove the spool valve assembly.

The spool valve can be cleaned by following **especially clean and careful procedures**. The seal (106), filter (105), restriction (104) and spring (100) are located at the ends of the spool valve (102, 103). The spool (97) can also be removed for cleaning.

NOTE:
Each spool valve body has an individual matching spool which cannot be replaced by any other spool. Never change the orientation of the spool or the location of the individual spool springs.

Reassembly

- ☐ Place a new gasket (98) in the location determined by the fitting screw holes. Fit the spool valve into its corresponding position on top of the seal and tighten the M4 screws (99) evenly.
- ☐ The O-rings must be mounted first in their grooves located in the spool valve unit. During mounting the O-rings must be compressed because the sealing is done radially. Make sure that the O-rings are evenly compressed and that they are fully inside the grooves. The O-rings must be in perfect condition; no defects are allowed. If a tool is used it must be blunt.
- ☐ Mount the prestage unit directly onto the spool valve unit. The ends of the nozzles will guide the prestage unit to the right location. The prestage unit must fit by pushing gently with no excessive force. Ensure that the spool valve unit and the prestage unit have an even surface connection before tightening the screws.

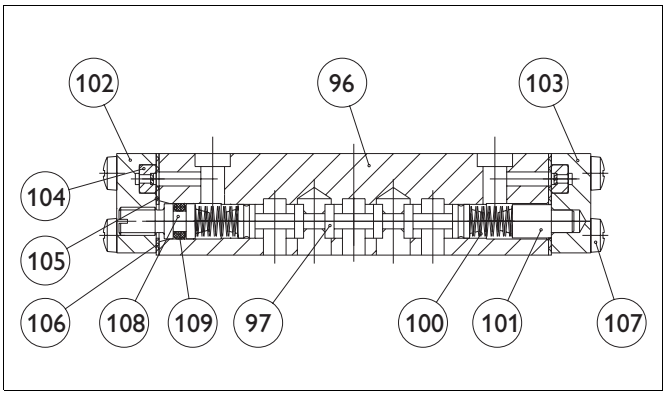


Fig. 13. Spool valve

5.3 Circuit board pack

Disassembly

- ☐ Loosen the M8 screw (66) and turn the position indicator (65) outwards from the feedback shaft.
- ☐ Unplug all wire connectors from the circuit board (5) and the signal wires from the terminal block (35).
- ☐ Remove the M3 screws (111, 5 pcs.).

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

- ☐ Take hold of the sides of circuit board and lift it directly upwards and outwards. Handle the board carefully, touching only the sides.

Reassembly

- ☐ Remount the circuit board pack carefully. Do not let the feedback shaft touch the circuit board.
- ☐ Locate the pins of the pressure sensor on the matching connections on the board.
- ☐ Tighten the M3 screws (111) evenly.
- ☐ Push the rubber grommet into the slot located on the intermediate wall of the body and connect the wires to the terminal block as shown in Fig. 14. Plug the prestage wire connectors into the board making sure that the wires do not cross each other. Plug the position sensor (6) wire connector into the board.
- ☐ Mount the protective cover (46).
- ☐ Mount the position indicator (65) on the shaft and tighten the M8 screw (66) temporarily. The final locking of the position indicator occurs when the actuator is installed.

NOTE:
Changing a new circuit board pack requires updating the module parameters using PDM communication. See the instructions provided with the new circuit board.

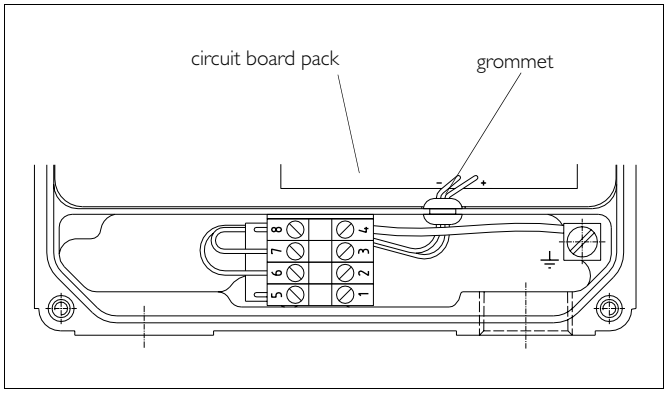


Fig. 14. Circuit board pack

5.4 Position sensor

Before loosening the position sensor (6) first loosen the circuit board according to 5.3.

The position sensor assembly (6) consists of the MR-sensor (114), which is fixed to the housing, and the spiral (117), which is fixed to the main shaft.

Disassembly

- ☐ Loosen the M3 screws (116, 2 pcs.) and lift the sensor out of the housing.
- ☐ Remove the lock ring (119) from the shaft and open the hexagonal socket screw (118, 2 pcs.). Mark the top of the spiral before removing it. Slide the spiral out of the shaft.

Reassembly

- ☐ Mount the new sensor and spiral together as a pair. Slide the spiral back onto the shaft and replace the lock ring on the shaft. Turn the spiral and the shaft to the position shown in the Fig. 15, corresponding to a 45° valve opening. Tighten the M3 screws.
- ☐ Install a 0,1 mm (0.004 in) thick gauge strip between the sensor and the spiral. Press the sensor against the spiral, without using unnecessary force, and tighten the screws (116) evenly. Remove the strip.
- ☐ Mount the circuit board and the protective cover (46) as directed in 5.3.

NOTE:
Changing the new position sensor requires updating of the calibration values of the sensor using PDM. See the instructions in the ND800PA User's guide.

5.5 Pressure sensor

Before removing the pressure sensor (7) you must loosen the circuit board according to 5.3.

Disassembly

- ☐ Loosen the M3 screws (126, 2 pcs.) and lift out the pressure sensor (7) holding it from the both ends.

Reassembly

- ☐ Mount the O-rings (123, 2 pcs.) in their grooves in the housing. Push the pressure sensor back into place, guided by the O-rings. The final location is shown in Fig. 16. Tighten the M3 screws evenly.
- ☐ Replace the circuit board and the protective cover according to 5.3.

NOTE:
Changing the pressure sensor requires updating of the calibration values of the sensor using PDM communication. See the instructions in the ND800PA User's guide.

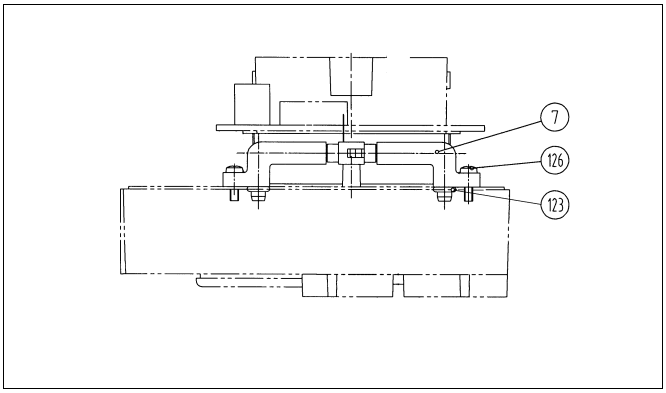


Fig. 16. Pressure sensor

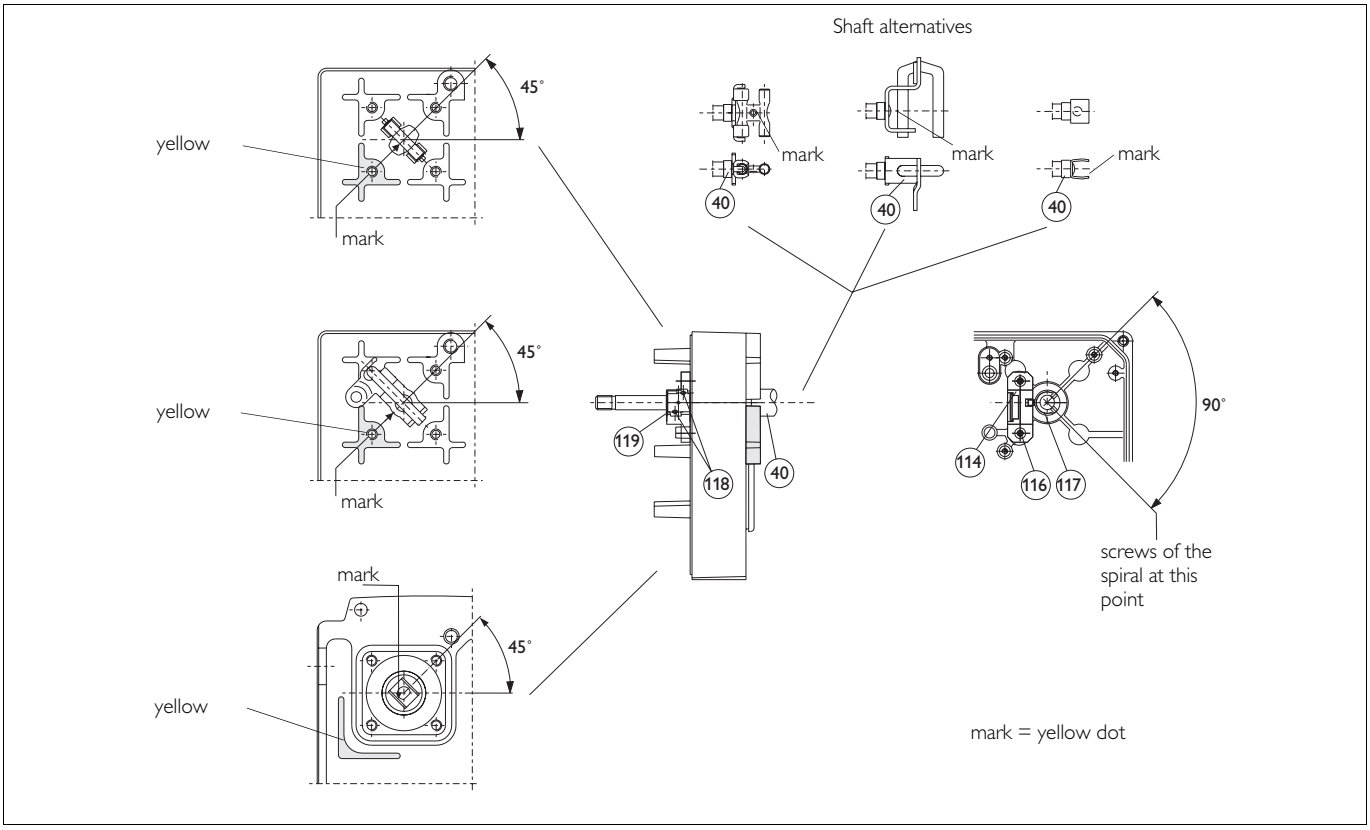


Fig. 15. Position sensor

6 ERROR MESSAGES

When the ND800PA detects serious device failure (analogue inputs, analogue outputs or electronics) it enters fail-safe mode which drives the control valve into the position defined in the parameter positioner fail action (*PFA*). Fail-safe mode is indicated by the LCD as message *Exx*, where *xx* is a number between 1-99, or by the PDM. The error message is displayed until the cause of error is eliminated and the ND800PA unit is cold-started, i.e. the fieldbus is momentarily disconnected. Cold-start can also be done using PDM.

When the ND800PA detects an error during travel calibration or self-tuning, the error message *Err* is displayed. It disappears when any key is pressed.

The ND800PA stores error messages in its non-volatile memory, which saves the 20 most recent error codes. The memory can be read out with PDM.

Table 4 lists the error messages shown on the LCD display and their explanations.

Table 4. Error messages shown on LCD display

Error message	Reason	Action
E41	Pneumatic prestage valve 1 (VA1) control failure.	Check wires and connectors or change circuit board. Resistance of the coil is approx. 100 Ω, measured from the prestage connectors.
E44	Pneumatic prestage valve 2 (VA2) control failure.	Check wires and connectors or change circuit board. Resistance of the coil is approx. 100 Ω, measured from the prestage connectors.
E51	Position feedback ADC low limit failure.	Check the mounting of controller; the mark on the shaft must stay in the right sector, see Fig. 4. Check wires, connector and position sensor rotation range or change circuit board. Rotate the position feedback shaft 10 degrees counterclockwise and cold-start the device.
E52	Position feedback ADC high limit failure.	Check the mounting of controller; the mark on the shaft must stay in the right sector, see Fig. 4. Check wires, connector and position sensor rotation range or change circuit board. Rotate the position feedback shaft 10 degrees clockwise and cold-start the device.
E61	Memory (EEPROM) failure.	Change circuit board.
E65	Memory (EEPROM) failure.	Change circuit board.
E81	Memory (RAM) failure.	Change circuit board.
E82	Memory (ROM) failure.	Change circuit board.
E91	Processor failure.	Change circuit board.
Err	Zero and travel calibration or self-tuning fails.	Check range of position sensor or mechanical limits of actuator. Check wires and connectors. Check leakage. Check that spool valve does not stick. Check that prestage is not defective.

ADC = analog/digital converter

7 TROUBLE SHOOTING

Mechanical/electrical defects

1. A change in the valve position setpoint does not affect the position of the actuator
- ☐ supply pressure too low
- ☐ spool valve sticks
- ☐ tubes between controller and actuator are incorrect, see Fig. 7
- ☐ actuator and/or valve jammed
- ☐ signal wires incorrectly connected, no value on display
- ☐ circuit board is defective
- ☐ calibration has not been carried out (**AUT●** or **MAN**)
- ☐ ND800PA is either in **MAN** or **OFF** mode
- ☐ prestage is defective
- ☐ position sensor is defective

2. The actuator goes to the final position with a small change of input signal
- ☐ tubes between controller and actuator are incorrect, see Fig. 7
- ☐ the parameter settings *PFA* and *rat* are incorrectly selected. See Figs. 7 and 10

3. Inaccurate positioning
- ☐ spool valve dirty
- ☐ dirt in the permanent magnet air gap
- ☐ actuator too small
- ☐ supply pressure too low
- ☐ pressure sensor is defective
- ☐ *d* and *b* parameters in the **DB** mode do not comply with recommendations shown in Fig. 7
- ☐ **GAIN** parameter is too small, perform **AUT●** / **MAN** calibration acc. to Section 4.2

4. Overshooting or positioning too slow
- ☐ **GAIN** is too high or too low, see Fig. 7
- ☐ 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. *Err* is shown during calibration
- ☐ position sensor is out of range, see Section 5.4
- ☐ mechanical actuator travel exceeds position sensor linear travel, i.e. 110°. If it fails in fully closed position, turn the spiral (117) counterclockwise in 5° steps. If it fails in the fully open position, turn the spiral (117) clockwise in 5° steps.
- ☐ the parameter settings *PFA* and *rat* are incorrectly selected, see Section 4.3 and Fig. 7
- ☐ the actuator did not move or was stuck during calibration
- ☐ ND800PA/actuator mounting is incorrect, see Figs. 4, 5, 15 and Sections 10.2-10.6
- ☐ spool valve sticks
- ☐ prestage is defective

PDM trouble shooting is explained in the ND800PA User's Guide.

8 TOOLS

No special tools needed.

9 ORDERING SPARE PARTS

Spare parts are delivered as modules. Available modules are shown in Section 11.1.

When ordering spare parts, always include the following information:
- ☐ controller type designation and serial number from the ID plate
- ☐ code of this manual, part number, part name and quantity required
- ☐ When ordering the circuit board, serial number of the position sensor

10 ND800PA/K06B (WITH LIMIT SWITCHES)

10.1 Introduction

10.1.1 General description

ND800 can be equipped with limit switches. ND800PA/K00B has 2 microswitches.

Limit switches are used for electrical position indication of the valves and other devices.

The switching points can be chosen freely.

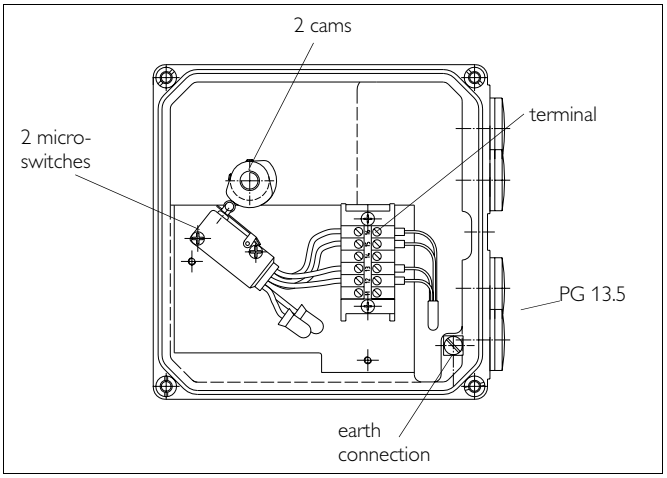


Fig. 17. ND800/K06B layout

10.1.2 Markings

The limit switch is provided with an identification plate sticker, see Fig. 18. Identification plate markings from top to bottom are:

- ☐ Type designation
- ☐ Electrical values
- ☐ Enclosure class
- ☐ Temperature range
- ☐ Conduit entry
- ☐ Serial number

The type designation is described in Chapter 13.

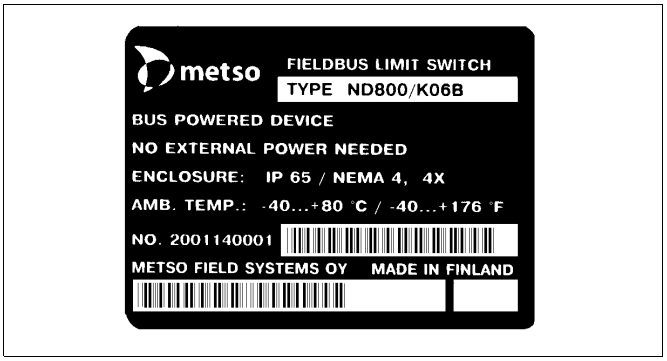


Fig. 18. Identification plate

10.1.3 Technical specifications

10.1.3.1 ND800PA/K06B

Microswitch type:	OMRON D2VW-01 (gold plated contacts) Protection class IP67	(06)
Resistive load:	100 mA: 30 V DC/125 V AC	(06)
Switch accuracy:	< 2°	
Number of switches:	2	
Protection class of cover:	IP65 (DIN 40050, IEC 529)	
Conduit entry:	PG 13.5 1/2 NPT = -L M20x1.5 = -I R 1/2 = -NJ	
Ambient temperature:	-20 - +80 °C (-4 - +176 °F)	
Weight:	Approx. 0.8 kg (1.8 lbs) (limit switches only)	
Materials:		
Body:	Aluminium alloy, epoxy-coated	
Internal parts:	Stainless steel and plastic	
Sealing:	Nitrile and neoprene rubber	

10.1.4 Safety precautions

CAUTION:
Do not exceed the limit switch performance limitations!
Exceeding the limitations marked on the limit switch may cause damage to the limit switch, actuator and valve. Damage or personal injury may result.

CAUTION:
Observe caution with the live parts of the limit switch!
The limit switches are fed with a voltage that, depending on the system, may be lethal.
Do not touch any uncovered parts of the wires. Always disconnect the wires before dismantling the limit switch.

10.2 Installing ND800PA/K06B on a valve controller

The limit switch can be installed on an existing valve controller.

NOTE:
Do not install a ND800/K06B limit switch on a ND800/X valve controller!

- ☐ If the valve controller is already mounted on an actuator/valve assembly, operate the actuator into the closed or open position.
- ☐ Remove the cover (2) and the pointer (65).
- ☐ Turn the shaft (304) onto the shaft (40). Fasten the screw (305) using a locking agent such as Loctite. Unfasten the screws (331) in the cam discs (330).
- ☐ Mount the housing (300) on the valve controller. Turn the cam discs (330) to avoid contact with the microswitches, if needed.
- ☐ Mount the pointer (65) on the shaft (304).
- ☐ Adjust the limit switch according to Section 10.4.

10.3 Electrical connections

Before connecting the power, make sure that the electrical specifications and the wiring meet the installation conditions. See the diagram in Section 11.12. See also the information on the identification plate.

10.4 Adjustment

The pointer (65) need not be removed for adjustment.

When the limit switch is ordered together with the valve and the actuator, the valve controller switches are factory-adjusted.

The limits can be adjusted by changing the position of the cam discs (330) on the shaft. The lower switch is activated at the closed limit and the upper switch at the open limit.

With the actuator in the open or closed position, find the switching point by turning the cam disc so that the switch changes about 5°-6° before the limit.

After re-installation of the actuator, first adjust its mechanical limits according to the valve, then the valve controller, and finally the limit switch.

When adjustment is completed, turn the pointer (65) so that the yellow line is parallel with the valve closure member.

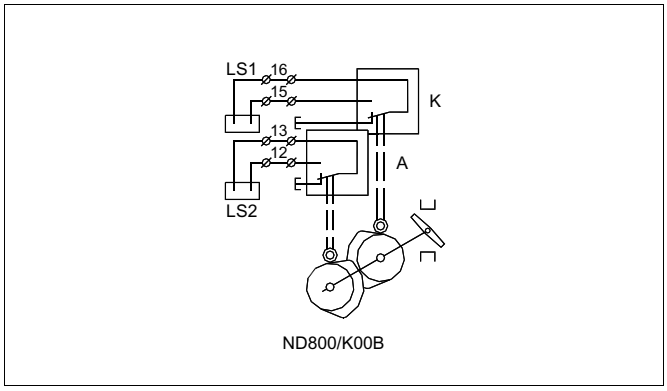


Fig. 19. Limit switch adjustment, ND800/K06B

10.5 Removal of the limit switch ND800PA/K06B for accessing the valve controller

Before the protective cover (46) can be removed the limit switch must be detached.

- ☐ Remove the cover (2) and the pointer (65).
- ☐ Loosen the screws (302) and remove the housing (300).
- ☐ Detach the shaft (304) with cam discs (330).
- ☐ Proceed with the valve controller as applicable.

Re-install the limit switch according to Section 10.2 and check the adjustment according to Section 10.4.

10.6 Circuit diagrams

The internal circuitry of the limit switch is shown in the connection diagram in Section 11.12 and on the sticker inside the cover.

10.7 Maintenance

Regular maintenance of the limit switch is not necessary.

10.8 Ordering spare parts

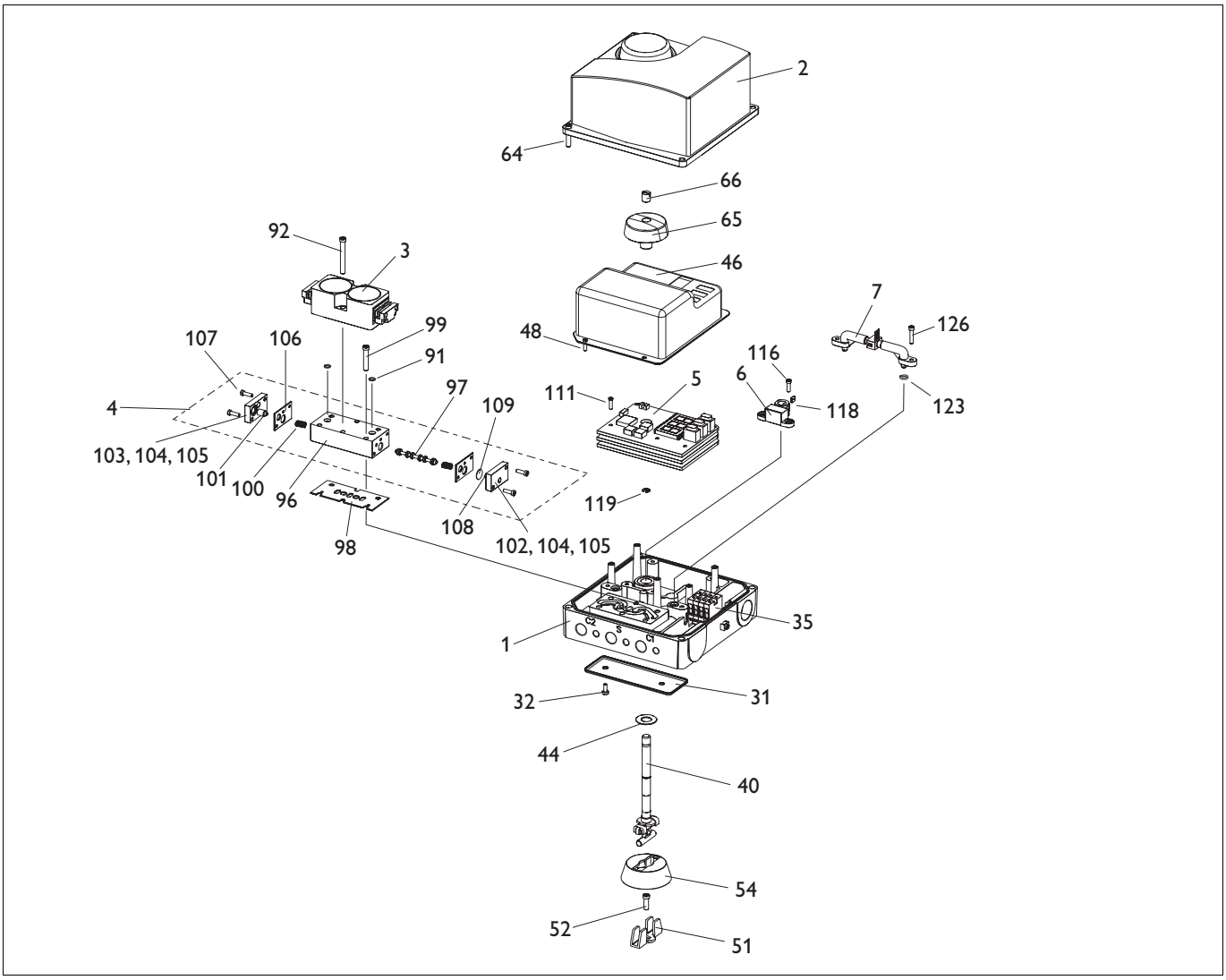
NOTE:
Always use original spare parts to make sure that the limit switch functions as intended.

When ordering spare parts, always include the following information:

- ☐ limit switch type designation (from the name plate or switch documents)
- ☐ number of the spare parts list or number of this manual, part number, part name and quantity required

11 DRAWINGS AND PARTS LISTS

11.1 Exploded view and parts list

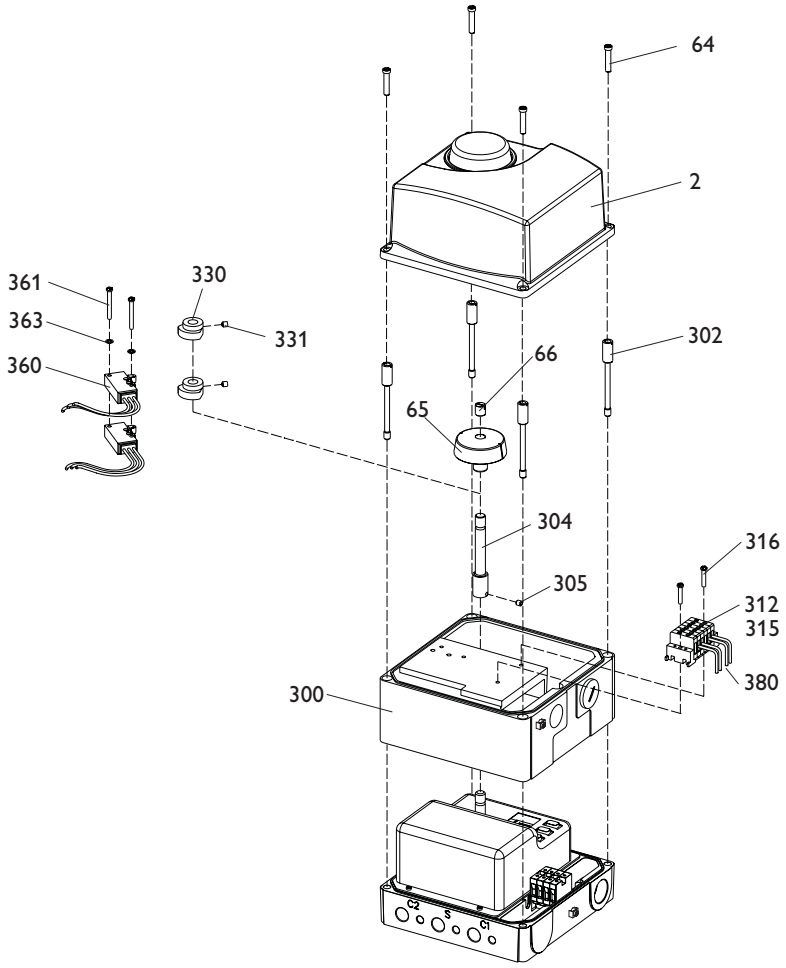


Item	Qty	Description	Recommended spare
1	1	Housing	
2	1	Cover	
3	1	Prestage unit *	
4	1	Spool valve assembly *	×
5	1	Circuit board pack	
6	1	Position sensor *	
7	1	Differential pressure sensor *	
31	1	Exhaust cover	
32	2	Screw	
35	4	Terminal block	
40	1	Shaft assembly	
44	1	Washer	
46	1	Protective cover	
48	4	Screw	
51	1	Ear	
52	1	Screw	
54	1	Couplings jacket	
64	4	Screw	
65	1	Pointer	
66	1	Screw	
91	2	O-ring	×
92	2	Screw	

Item	Qty	Description	Recommended spare
96	1	Spool valve body **	
97	1	Spool **	
98	1	Gasket	×
99	4	Screw	
100	2	Spring **	
101	1	Back stop **	
102	1	End piece I **	
103	1	End piece II **	
104	2	Restriction **	
105	2	Filter **	
106	2	Gasket **	
107	4	Screw **	
108	1	Adjustable back stop **	
109	1	O-ring **	
111	5	Screw	
116	2	Screw	
118	2	Screw	
119	1	Lock ring	
123	2	O-ring	
126	2	Screw	

*) delivered as a module
**) part of the spool valve assembly

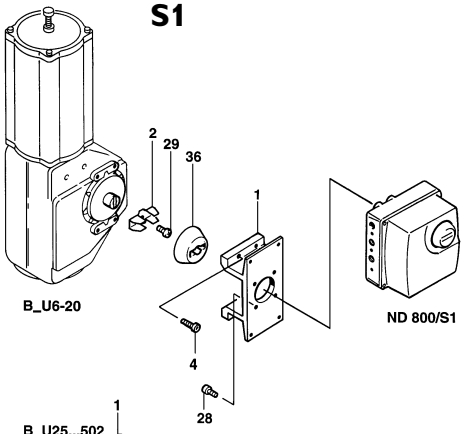
11.2 Exploded view and parts, ND800PA/K06B

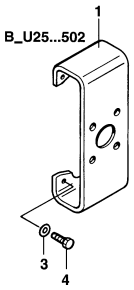


Item	Qty	Description	Recommended spare
2	1	Cover	
64	4	Screw	
65	1	Pointer	
66	1	Screw	
300	1	Housing	
302	4	Screw	
304	1	Shaft	
305	1	Screw	
312	6	Terminal block	
315	2	End stop	
316	2	Screw	
330	2	Cam disc	
331	2	Screw	
360	2	Microswitch	
361	2	Screw	
363	2	Spring washer	
380		Wire	

11.3 Mounting parts for B1C/B1J 6-20 actuators

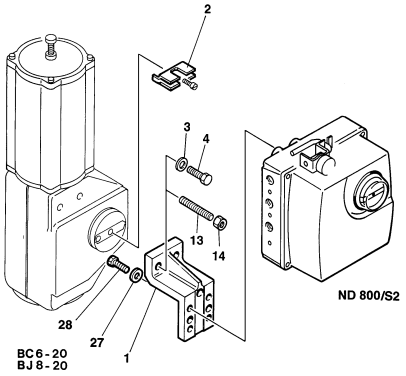
S1





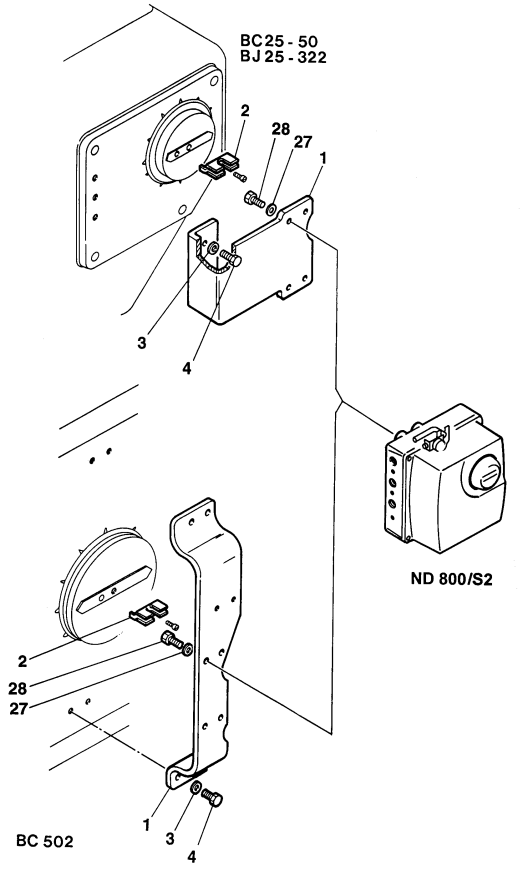
Item	Qty	Description
1	1	Mounting bracket
2	1	Ear
3	4	Washer
4	4	Screw
28	4	Screw
29	1	Screw
36	1	Coupling jacket

S2



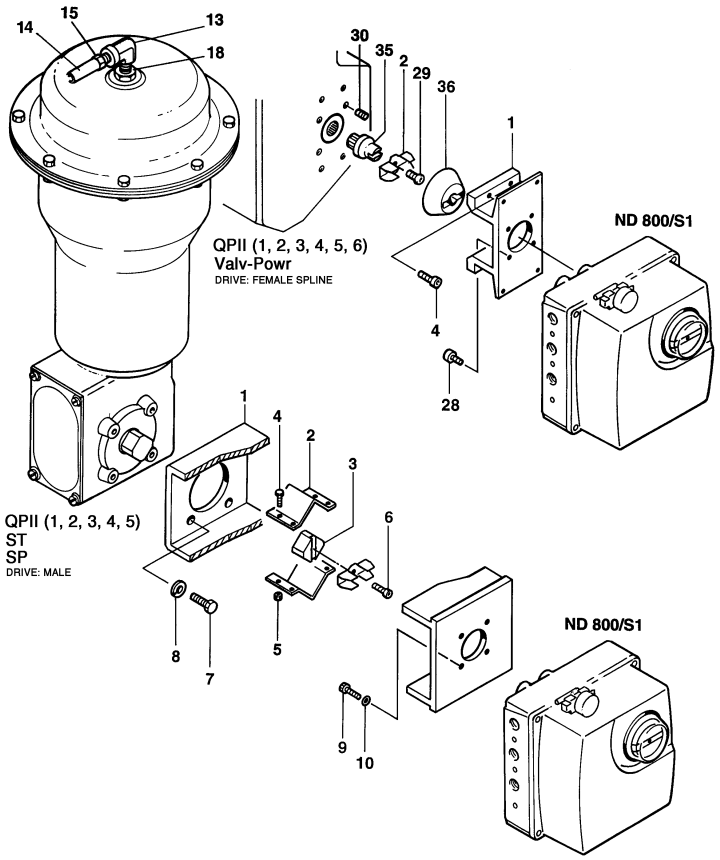
Item	Qty	Description
1	1	Mounting bracket
2	1	Draught piece
3	4	Washer
4	4	Screw
13	2	Screw
14	2	Hexagon nut
28	4	Screw
29	1	Screw

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



Item	Qty	Description
1	1	Mounting bracket
2	1	Draught piece
3	4	Washer
4	4	Screw
27	4	Washer
28	4	Screw

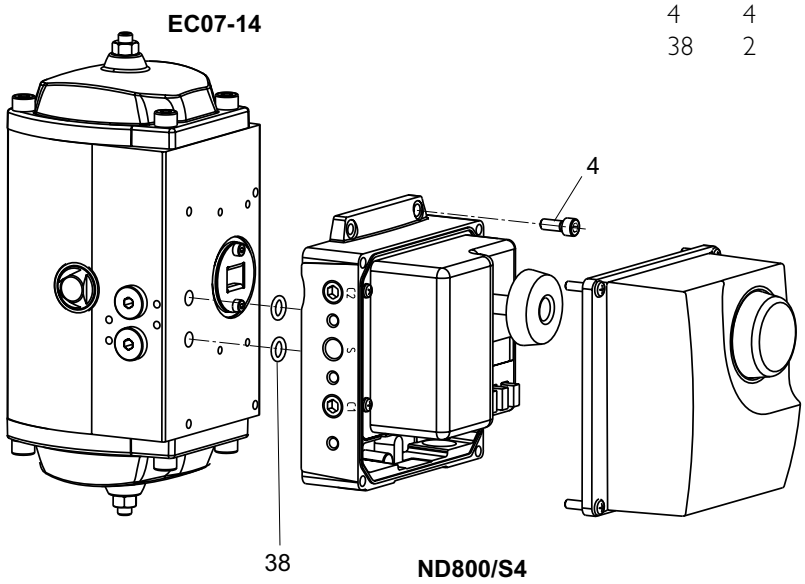
11.5 Mounting parts for Quadra-Powr®, ST, SP and Valv-Powr® actuators



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	Coupling jacket

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

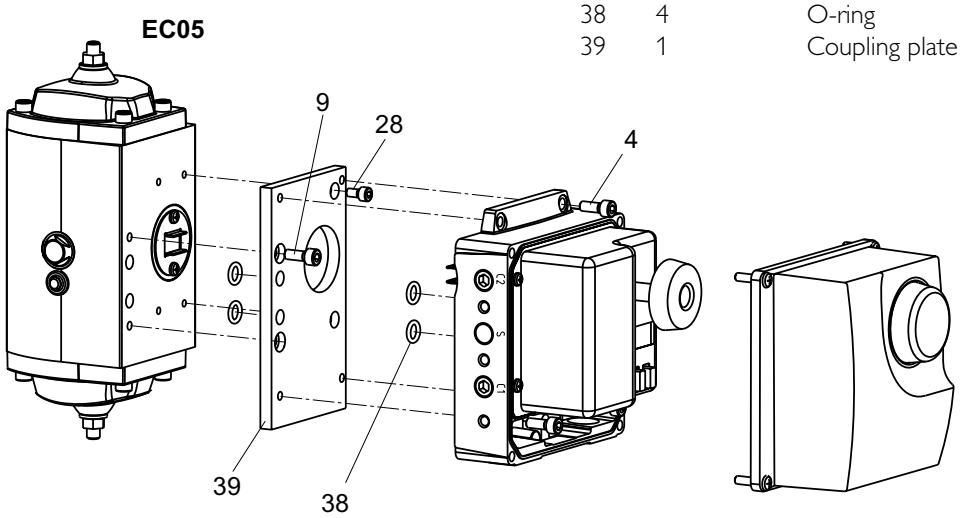
11.6 Mounting parts for EC07-14 actuators, rising signal opens valve



Item	Qty	Description
4	4	Screw
38	2	O-ring

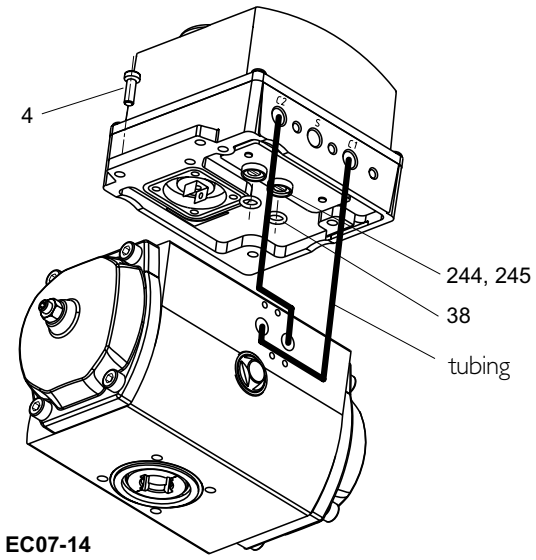
11.7 Mounting parts for EC05 actuators, rising signal opens/closes valve

Item	Qty	Description
4	4	Screw
9	2	Screw
28	2	Screw
38	4	O-ring
39	1	Coupling plate (acc. to action)

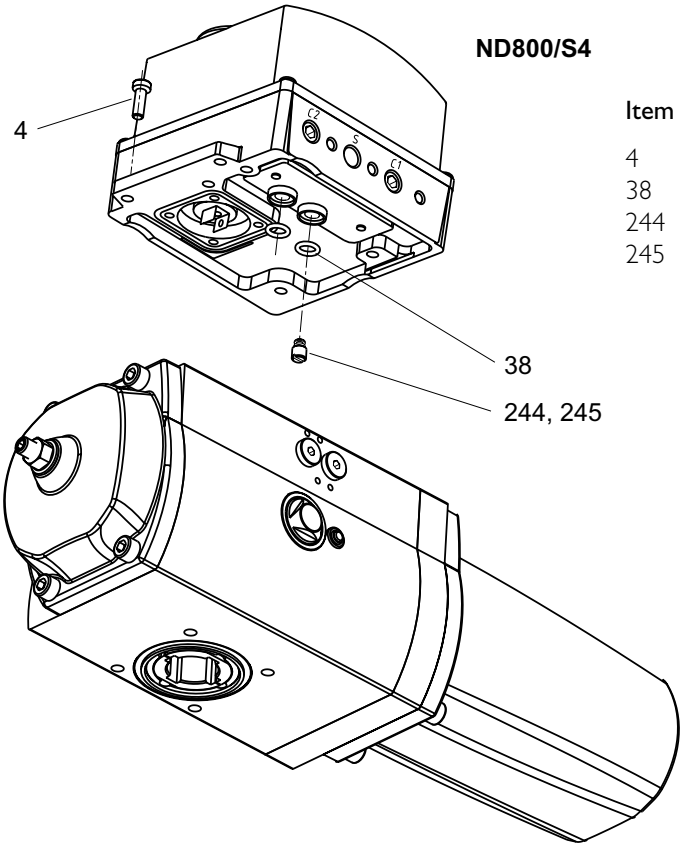


11.8 Mounting parts for EC07-14 actuators, rising signal closes valve

Item	Qty	Description
4	4	Screw
38	2	O-ring
244	2	Plug
245	2	O-ring

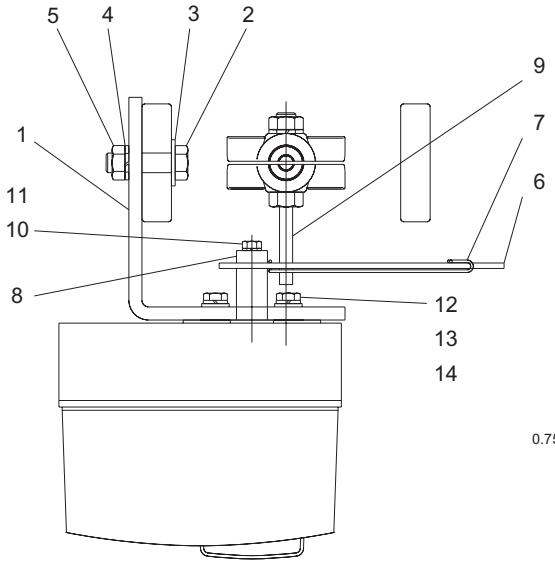


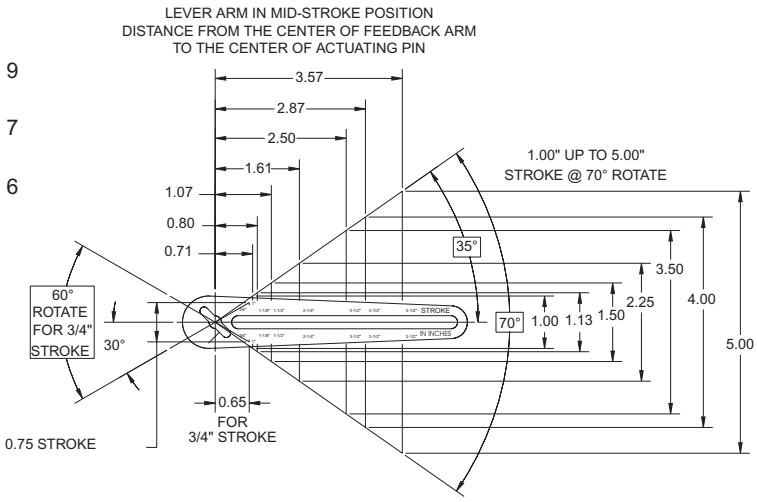
11.9 Mounting parts for EJ05-14 actuators



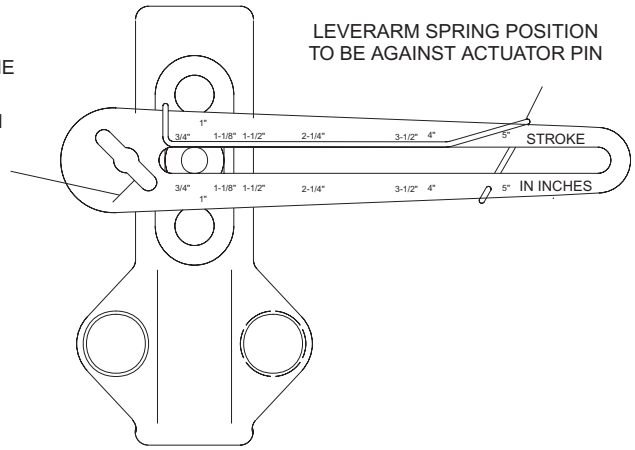
Item	Qty	Description
4	4	Screw
38	2	O-ring
244	1	Plug
245	1	O-ring

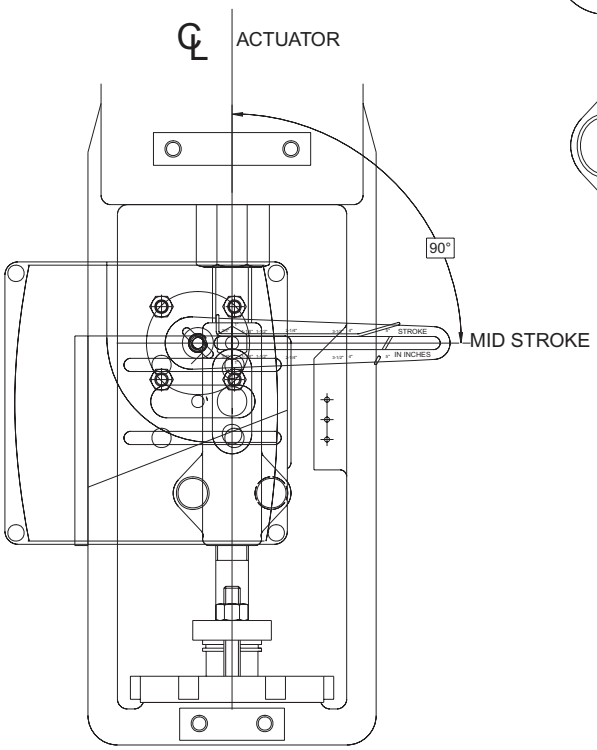
11.10 Mounting parts for D/R linear actuators





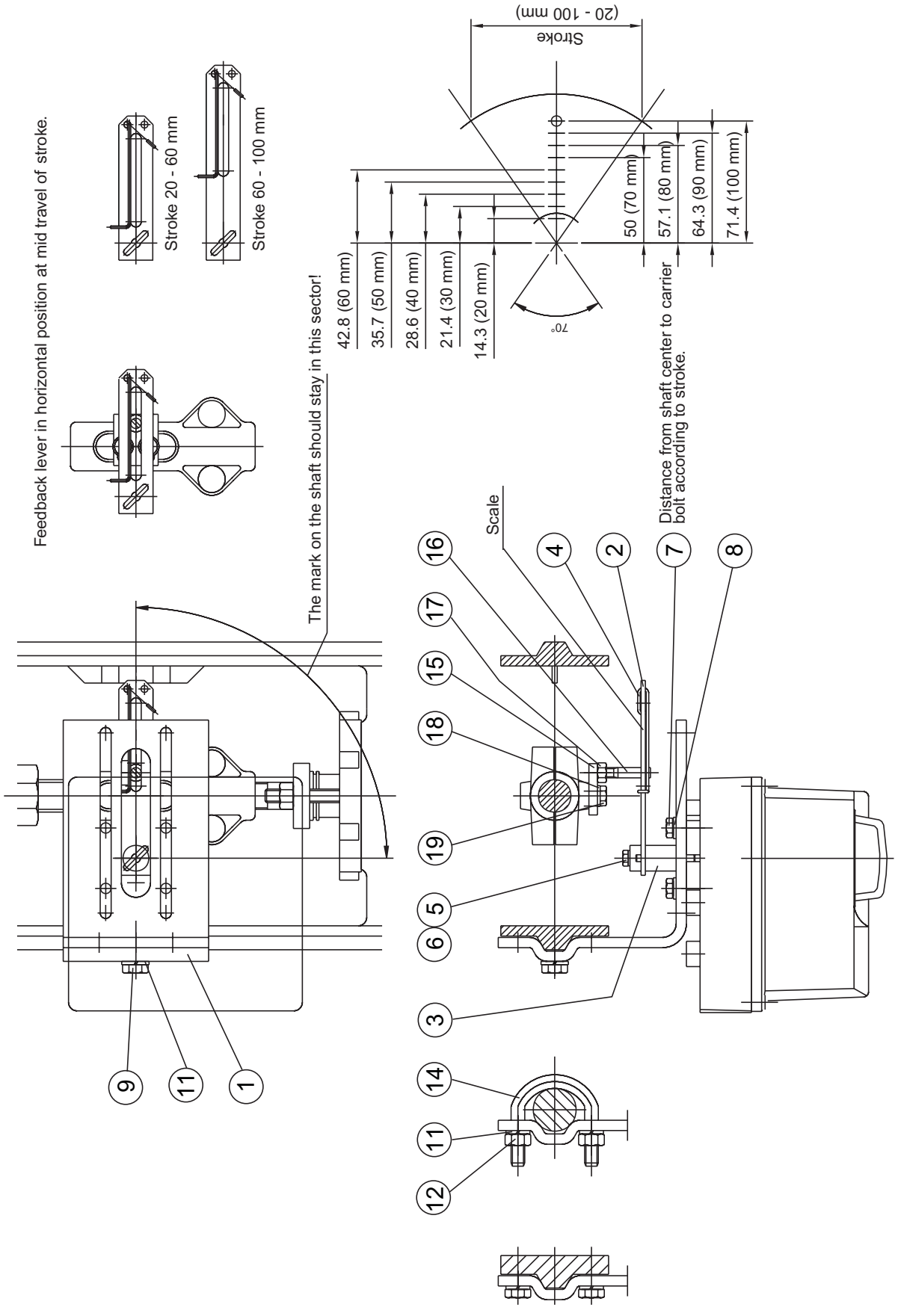
MAKE SURE THIS MARK ON THE LEVER ARM IS IN THE SAME QUADRANT AS THE MARK ON THE FLAT OF THE SHAFT.





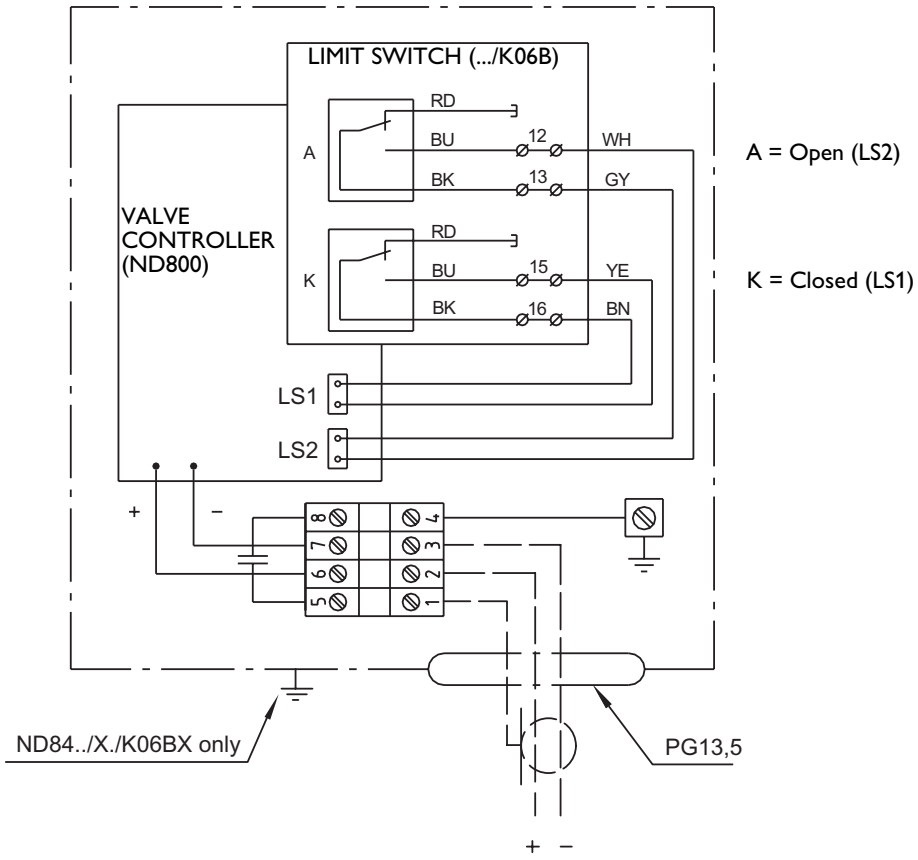
Item	Qty	Description
1	1	Mounting bracket
2	2	Screw
3	2	Flat washer
4	2	Lock washer
5	2	Hex nut
6	1	Positioner lever arm
7	4	Linkage arm spring
9	1	Positioner pin
10	1	Screw
11	2	Lock washer
12	4	Screw
13	4	Lock washer
14	4	Flat washer

11.11 Mounting parts for linear actuators with IEC 60534 mounting face



11.12 Connections

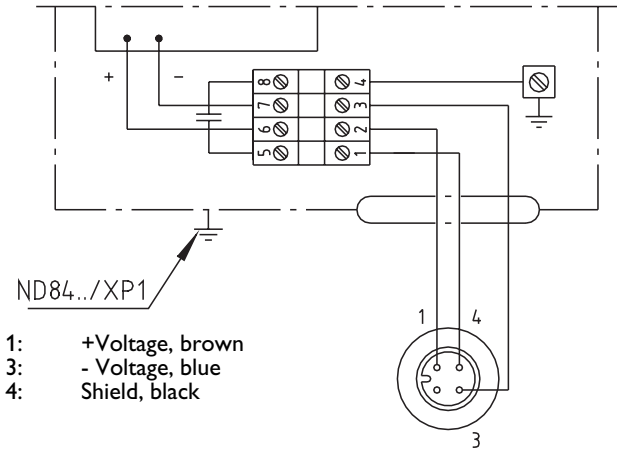
11.12.1 Connection diagram for ND800PA/K06B



ND84../../K06B
With limit switch OMRON D2VW-01 micro switches

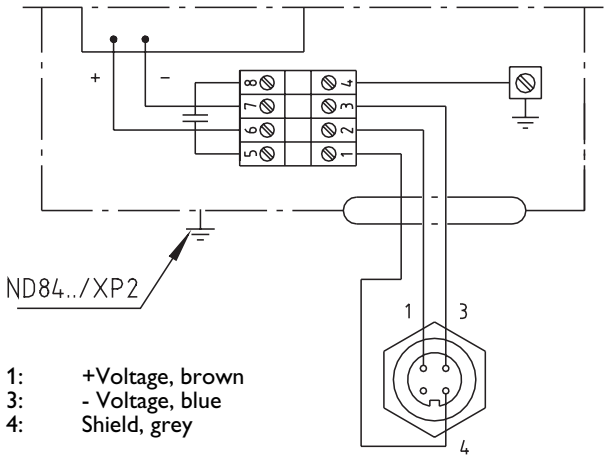
Connection diagram shows limit switch when actuator is in intermediate position.
Switch A (upper) is activated at the open limit of the travel and switch K (lower) at the closed limit.

11.12.2 Device gland receptacles



1: +Voltage, brown
3: - Voltage, blue
4: Shield, black

ND84.../...P1 = male type WEIDMÜLLER 945565, PG13.5/M12

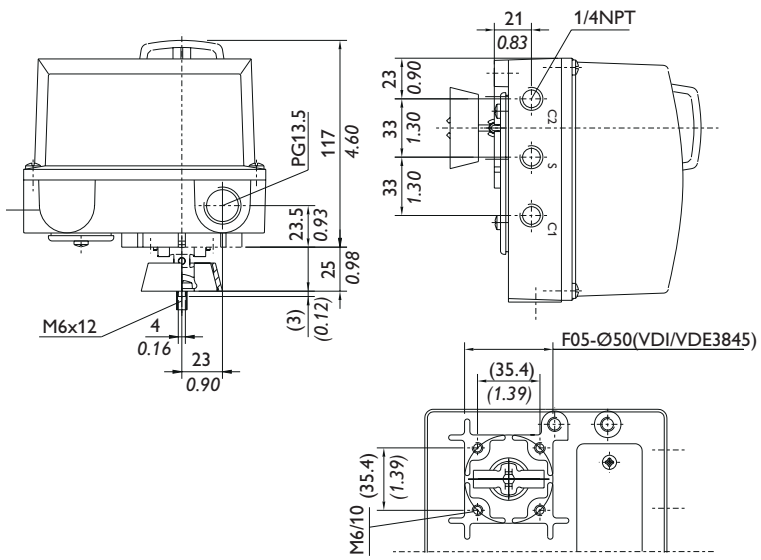


1: +Voltage, brown
3: - Voltage, blue
4: Shield, grey

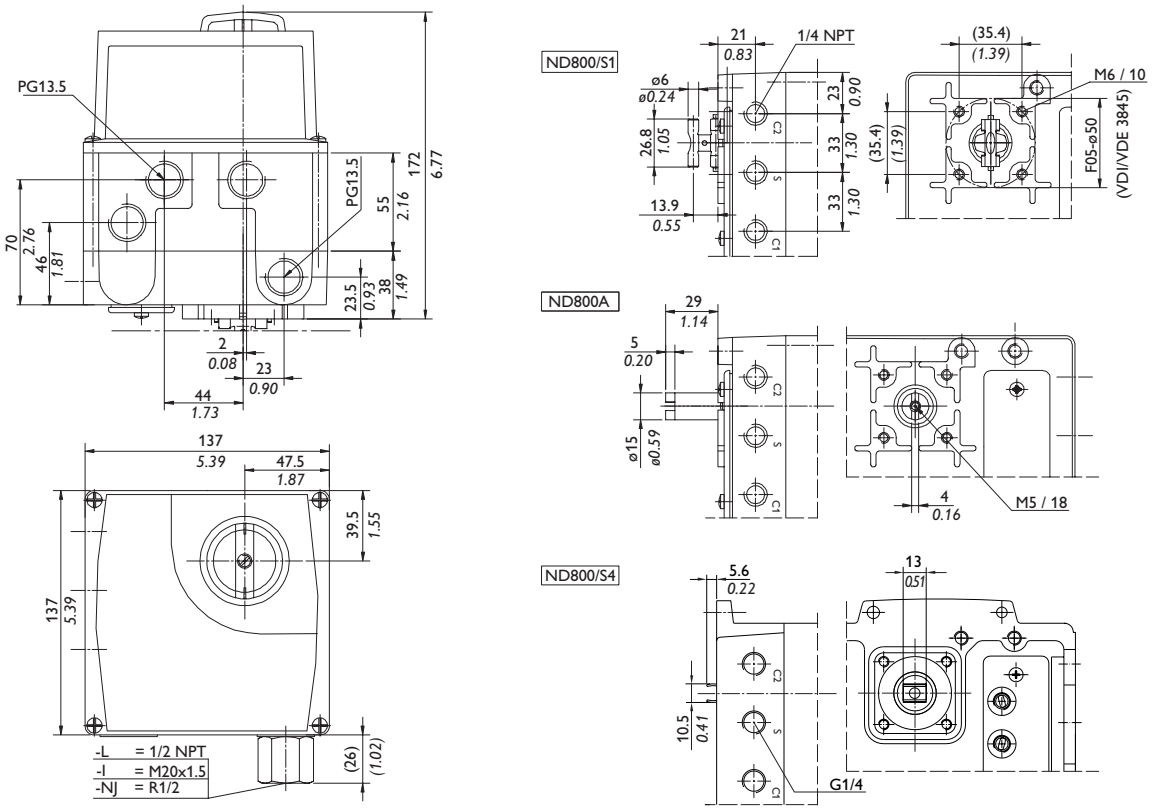
ND84.../...P2 = male minifast type TURCK RSFV48/13.5

12 DIMENSIONS

ND800PA/S1

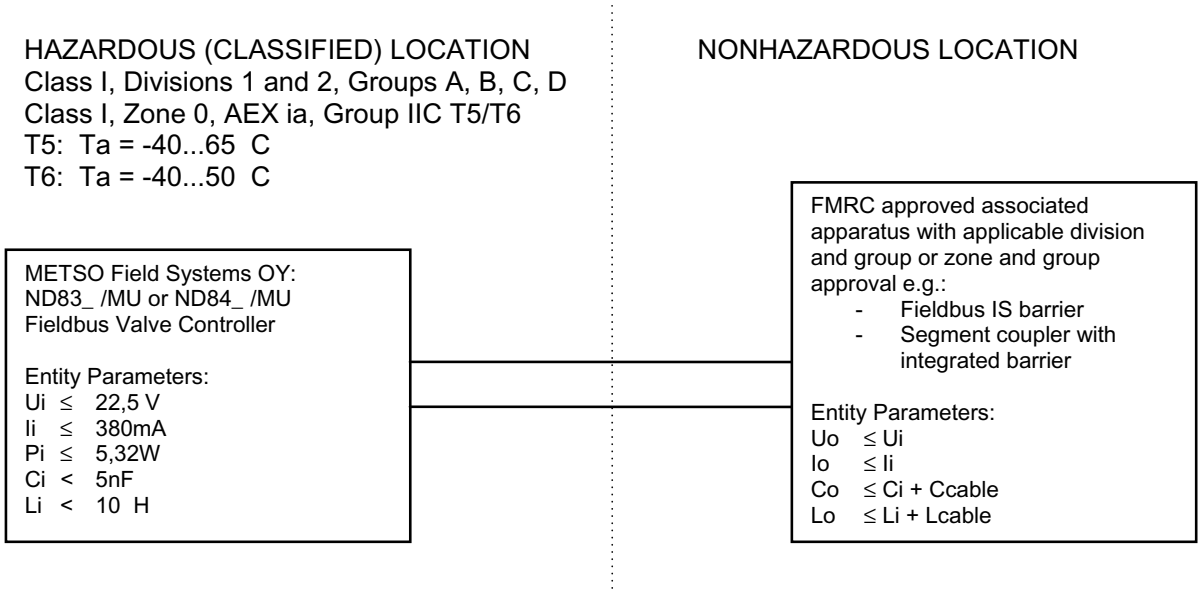


ND800PA/S1/K00B



13 CONTROL DRAWINGS

13.1 FMRC control drawing for ND84_/MU (ND84_/NU)



Notes:

1. For installation in a Division 1 hazardous (classified) location, the wiring must be in accordance with the National Electrical Code Article 504-20. For installation in a Zone 0 hazardous (classified) location, the wiring must be in accordance with the National Electrical Code Article 505.

2. The Entity Concept allows interconnection of intrinsically safe and associated apparatus not specifically examined in combination as a system when the approved values of Voc (or Uo) and Isc (or Io) for the associated apparatus are less than or equal to Vmax (or Ui) and Imax (or Ii) for the intrinsically safe apparatus and the approved values of Ca (or Co) and La (or Lo) for the associated apparatus are greater than Ci + Ccable, Li + Lcable, respectively for the intrinsically safe apparatus.

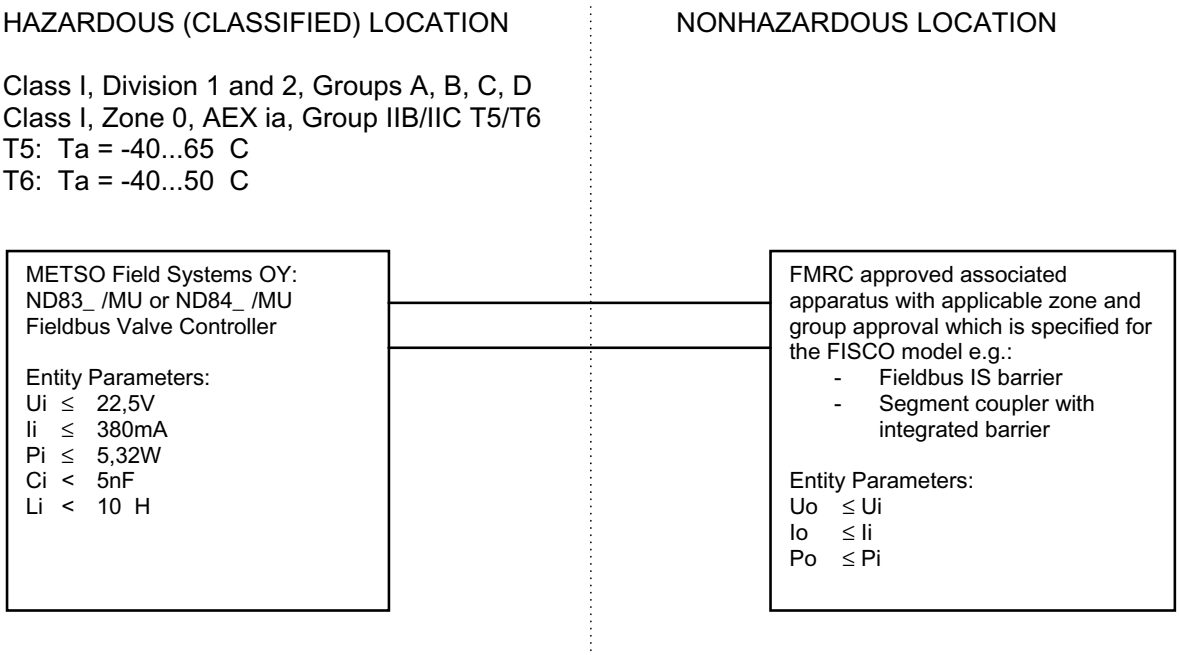
3. Note associated apparatus with only Zone 1 approved connections limits the mounting of the valve controller to Zone 1. Also associated apparatus with Group IIB connections or if in minimum one device at the fieldbus cable is specified only with IIB limits the complete fieldbus segment to IIB.

4. The metallic enclosure of the ND800 valve controller must be grounded and bonded in accordance with the National Electrical Code ANSI / NFPA 70, Article 250

5. The cover of the ND800 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.

6. The valve controllers ND83_/NU and ND84_/NU are non-incendive for Class I, Division 2, Groups A,B,C and D; Class I, Zone 2, Groups IIC, IIB, IIA T5 / T6 hazardous (classified) locations and need to be connected to an associated apparatus with a max. output voltage of 22,5V.

Control Drawing for Installations according to the FISCO Model:
This concept may only be applied if all devices at the fieldbus line are approved and specified for the FISCO model, also the barrier of Segment coupler must be specified for the FISCO model.



Notes:

7. For installation in a Division 1 hazardous (classified) location, the wiring must be in accordance with the National Electrical Code Article 504-20. For installation in a Zone 0 hazardous (classified) location, the wiring must be in accordance with the National Electrical Code Article 505.

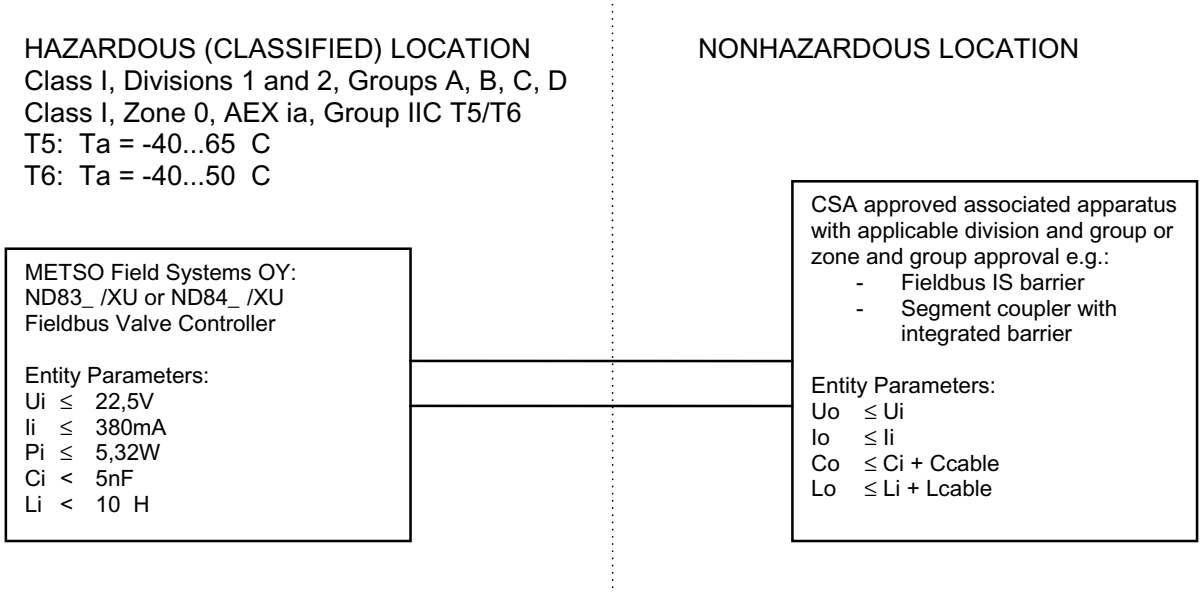
8. The Entity Concept together with the FISCO model allows interconnection of intrinsically safe and associated apparatus not specifically examined in combination as a system when the approved values of Uo and Io and Po for the associated apparatus are less than or equal to Ui and Ii and Pi for the intrinsically safe apparatus. If the cable is specified with the following parameters:
   R = 15 .150 O hm / km
   L = 0,4 1mH / km
   C = 80 .200n F / km (inclusive shielding)
   A max. cable length of 5000m is allowed if all devices connected to the cable are approved and specified to the FISCO model.

9. Note associated apparatus with only Zone 1 approved connections limits the mounting of the valve controller to Zone 1. Also associated apparatus with Group IIB connections or if in minimum one device at the fieldbus cable is specified only with IIB limits the complete fieldbus segment to IIB.

10. The metallic enclosure of the ND800 valve controller must be grounded and bonded in accordance with the National Electrical Code ANSI / NFPA 70, Article 250

11. The cover of the ND800 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.

13.2 CSA control drawing for ND84_/XU (ND84_/ZU)



Notes:

1. For installation in a Division 1 hazardous (classified) location or a Zone 0 / 1 hazardous (classified) location, the wiring must be in accordance with the Canadian Electrical Code CSA C22.1 Part 1.

2. The Entity Concept allows interconnection of intrinsically safe and associated apparatus not specifically examined in combination as a system when the approved values of Voc (or Uo) and Isc (or Io) for the associated apparatus are less than or equal to Vmax (or Ui) and Imax (or Ii) for the intrinsically safe apparatus and the approved values of Ca (or Co) and La (or Lo) for the associated apparatus are greater than Ci + Ccable, Li + Lcable, respectively for the intrinsically safe apparatus.

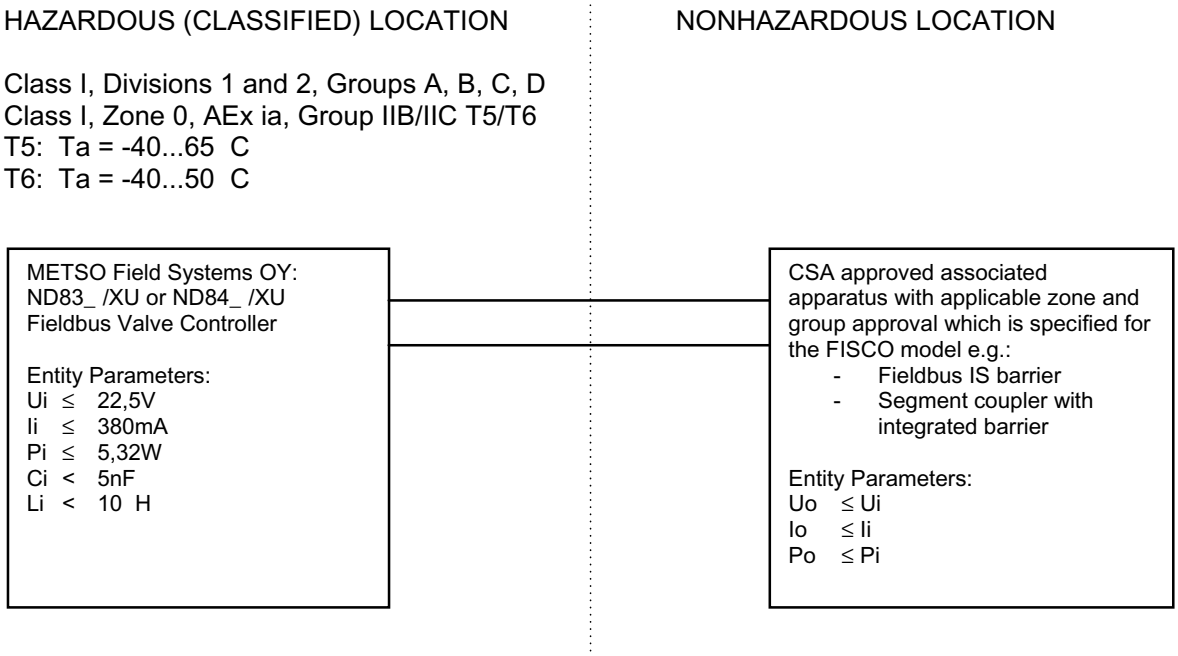
3. Note associated apparatus with only Zone 1 approved connections limits the mounting of the valve controller to Zone 1. Also associated apparatus with Group IIB connections or if in minimum one device at the fieldbus cable is specified only with IIB limits the complete fieldbus segment to IIB.

4. The metallic enclosure of the ND800 valve controller must be grounded and bonded in accordance with the Canadian Electrical Code CSA C22.1

5. The cover of the ND800 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.

6. The valve controllers ND83_/ZU and ND84_/ZU are non-incendive for Class I, Division 2, Groups A,B,C, and D; Class I, Zone 2, Groups IIC, IIB, IIA T5 / T6 hazardous (classified) locations and need to be connected to an associated apparatus with a max. output voltage of 22,5V.

Control Drawing for Installations according to the FISCO Model:
This concept may only be applied if all devices at the fieldbus line are approved and specified for the FISCO model, also the barrier of Segment coupler must be specified for the FISCO model.



Notes:

7. For installation in a Division 1 hazardous (classified) location or a Zone 0 / 1 hazardous (classified) location, the wiring must be in accordance with the Canadian Electrical Code CSA C22.1 Part 1.

8. The Entity Concept together with the FISCO model allows interconnection of intrinsically safe and associated apparatus not specifically examined in combination as a system when the approved values of Uo and Io and Po for the associated apparatus are less than or equal to Ui and Ii and Pi for the intrinsically safe apparatus. If the cable is specified with the following parameters:
   R = 15 .150 O hm / km
   L = 0,4 1mH / km
   C = 80 .200n F / km (inclusive shielding)
   A max. cable length of 5000m is allowed if all devices connected to the cable are approved and specified to the FISCO model.

9. Note associated apparatus with only Zone 1 approved connections limits the mounting of the valve controller to Zone 1. Also associated apparatus with Group IIB connections or if in minimum one device at the fieldbus cable is specified only with IIB limits the complete fieldbus segment to IIB.

10. The metallic enclosure of the ND800 valve controller must be grounded and bonded in accordance with the Canadian Electrical Code CSA C22.1

11. The cover of the ND800 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.

14 TYPE CODING

VALVE CONTROLLER ND800
LIMIT SWITCH (ND800/K00 or ND800/I00)

1.	2.	3.	4.	5.		6.		7.	8.	9.
ND	8	4	2	-	/	S1	—	K	06B	-

1. sign	PRODUCT GROUP
ND	Valve controller

2. sign	SERIES CODE
8	

3. sign	INPUT SIGNAL
4	Profibus PA Bus voltage 9-32 VDC Transmission system acc. to IEC 1158-2. Normative parts acc. to EN 50170 Vol. 2.

4. sign	SPOOL VALVE	CONNECTIONS (S, C1, C2)
1	Ø 1 mm, double acting, available only with EC actuators	1/4 NPT, G 1/4 (S4)
2	Ø 2 mm, double acting	1/4 NPT
6	Ø 6 mm, double acting	1/4 NPT
11	Ø 1 mm, 3-way spool valve, single action, available only with EJ actuators	1/4 NPT, G 1/4 (S4)
21	Ø 2 mm, 3-way spool, single action	1/4 NPT
61	Ø 6 mm, 3-way spool, single action	1/4 NPT

5. sign	ACTION
-	Double action, without sign. 4th sign should be 1, 2 or 6. In connection with B_CU6 to B_CU11, EC10 and EC12 actuators 4th sign must be 2. In connection with EC5 and EC07 actuators 4th sign must be 1.
	Single action, without sign. 4th sign should be 21 or 61. In connection with B_JU8, QP1, QP2, EJ07 and EJ10 actuators 4th sign should be 21. In connection with EJ05 4th sign must be 11. Not appplicable with double acting actuators.
A	Single action, linear motion, applicable to Metso Automation D/R series diaphragm actuator. Not applicable to attachment face according to VDI/VDE 3845 (6th sign S1). 21A is for RA and DA. 61A is for RB, RC, RD, RE and DB, DC, DE. Also applicable to linear actuators acc. to IEC 60534-6-1 with own linkage set. 4th sign 21 or 61 acc. to stroke volume for single action. Specify the stroke (20-60 mm or 60-100 mm).

6. sign	OPTIONS
-	Standard, IP 65 enclosure, NEMA 4 and 4X. Built-in display and local keypad. PG 13,5 conduit entry. Without sign. Temperature range -20 °C... +85 °C / -4 °F... +185 °F. Supply voltage 9-32 VDC. Operating current over full ambient temperature and supply voltage range is 20.1-23.45 mA. At 24 VDC typical operating current is 21.8 mA
C	Low temperature, -40 °C / -40 °F.
X	Intrinsically safe construction acc. to EN 50014, EN 50020 and EN 50284. II 1G (Zone 0), EEx ia IIC T5/T6 Ex nL IIC T5/T6 Ex nC IIC T5/T6 Temperature range T5; -20 °C...+65 °C / -4 °F...+149 °F, T6; +50 °C / +122 °F. Ui = 17.5 VDC, Ii = 360 mA (pending).
XU	CSA Class I, Divisions 1 and 2, Groups A, B, C and D. CSA Class I, Zone 0, AEx ia, Group IIC T5/T6. Temperature range T5; -20 °C...+65 °C / -4 °F...+149 °F, T6; +50 °C / +122 °F. 1/2 NPT conduit entry. Not available with any limit switches 7. sign I or K. Ui = 17.5 VDC, Ii = 360 mA (pending).
ZU	CSA Class I, Division 2, Groups A, B, C and D. CSA Class I, Zone 2, AEx ia, Group IIC T5/T6. Temperature range T5; -20 °C...+65 °C / -4 °F...+149 °F, T6; +50 °C / +122 °F 1/2 NPT conduit entry. Not available with any limit switches 7. sign I or K. Ui = 17.5 VDC, Ii = 360 mA (pending).
MU	FM Class I, Division 1, Groups A, B, C and D. FM Class I, Zone 0, AEx ia, Group IIC T5/T6. Temperature range T5; -20 °C...+65 °C / -4 °F...+149 °F, T6; +50 °C / +122 °F. 1/2 NPT conduit entry. Not available with any limit switches 7. sign I or K. Ui = 17.5 VDC, Ii = 360 mA (pending).
NU	FM Class I, Division 2, Groups A, B, C and D. FM Class I, Zone 2, AEx ia, Group IIC T5/T6. Temperature range T5; -20 °C...+65 °C / -4 °F...+149 °F, T6; +50 °C / +122 °F. 1/2 NPT conduit entry. Not available with any limit switches 7. sign I or K. Ui = 17.5 VDC, Ii = 360 mA (pending).
S1	Valve controller attachment face acc. to standard VDI/VDE 3845, equipped with an H-clip. When valve controllers are separate deliveries, VDI/VDE 3845 ear is supplied. Not applicable to linear actuators (5th sign A).
S4	Valve controller attachment face only for EC/EJ actuators without tubings. Pneumatic connections C, S1, S2; G 1/4.
A	Pressure gauges, scale bar/psi/kPa, basic material brass, nickel plated, housing stainless steel, glycerine filled. 5th sign always defined. Temperature range -40 °C... +70 °C / -40 °F... +158 °F.
P1	Connection plug male , Weidmüller 945565, PG13.5/M12. Not available with accessories L, I, NJ.
P2	Connection plug male minifast, Turck RSFV48 /13.5. Not available with accessories L, I, NJ.
Y	Special construction, to be specified.

7. sign	LIMIT SWITCH CODE
K	Micro swithes, defined with 8. sign

8. sign	LIMIT SWITCH TYPE
	Micro switches, 2 pcs.
06B	OMRON D2VW-01, gold plated contacts 30 VDC, I < 100 mA. Bus powered, no external power needed. Temperature range -40 °C ... +80 °C / -40 °F ...+176 °F. When option of ND84 valve controller is X (6. sign) then 9. sign always be X. Temperature range according to valve controller.

9. sign	OPTION OF LIMIT SWITCH
-	Standard IP 65 enclosure. NEMA 4 and 4X. PG 13.5 conduit entry (4 pcs). Temperature range according to switch type.
X	Intrisically safe construction. DEMKO EEx ia IIC T6 certification (EN 50014, EN 50020). Temperature range according to valve controller type.
P	Connection plug according to DIN 43650A/ISO 4400 (PG11). Not available with ND82, ND83, ND84 valve controllers options X, XU, ZU, MU, NU and accessories L, I, NJ.
Y	Special construction, to be specified.

	EXTERNAL CONNECTION PARTS
K	Filter regulator for supply air, type BELLOFRAM 51FR. Pressure gauge, scale bar/psi/kPa, basic material bras, nickel plated, housing stainless steel, glycerine filled. Specified on the option sticker. Filter size 5 µm. Temperature range -18 °C... +52 °C / 0 °F... +125 °F. Filter regulator with higher capacity needed for actuators BC40 and BJ32.
L	PG13.5 / 1/2 NPT conduit entry. Specified in the option sticker
I	PG13.5 / M20x1,5 conduit entry. Specified in the option sticker.
NJ	PG13.5 / R1/2 (PF1/2) conduit entry. Specified in the option sticker.

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