



AUTOMAX VALVE AUTOMATION SYSTEMS

APEX 9000 Digital Positioner

Installation Operation Maintenance

FCD AXENIM0132-01

1.1 Using

The following instructions are designed to assist in unpacking, installing and performing maintenance as required on FLOWSERVE products. Product users and maintenance personnel should thoroughly review this bulletin prior to installing, operating or performing any maintenance. In most cases FLOWSERVE valves, actuators and accessories are designed for specific applications (e.g. with regard to medium, pressure, temperature). For this reason they should not be used in other applications without first contacting the manufacturer.

1.2 Terms concerning safety

The safety terms DANGER, WARNING, CAUTION and NOTE are used in these instructions to highlight particular dangers and/ or to provide additional information on aspects that may not be readily apparent.



DANGER: indicates that death, severe personal injury and/or substantial property damage will occur if proper precautions are not taken.



WARNING: indicates that death, severe personal injury and/or substantial property damage can occur if proper precautions are not taken.



CAUTION: indicates that minor personal injury and/or property damage can occur if proper precautions are not taken.



NOTE: indicates and provides additional technical information, which may not be very obvious even to qualified personnel.

Compliance with other, not particularly emphasised notes, with regard to transport, assembly, operation and maintenance and with regard to technical documentation (e.g. in the operating instruction, product documentation or on the product itself) is essential, in order to avoid faults, which in themselves might directly or indirectly cause severe personal injury or property damage.

1.3 Protective clothing

FLOWSERVE products are often used in problematic applications (e.g. extremely high pressures, dangerous, toxic or corrosive mediums). In particular valves with bellows seals point to such applications. When performing service, inspection or repair operations always ensure, that the valve and actuator are depressurised and that the valve has been cleaned and is free from harmful substances. In such cases pay particular attention to personal protection (protective clothing, gloves, glasses etc.).



1.4 Qualified personnel

Qualified personnel are people who, on account of their training, experience and instruction and their knowledge of relevant standards, specifications, accident prevention regulations and operating conditions, have been authorised by those responsible for the safety of the plant to perform the necessary work and who can recognise and avoid possible dangers.

1.5 Installation

DANGER: Before installation check the order-no, serial-no. and/ or the tag-no. to ensure that the valve/actuator is correct for the intended application.

Do not insulate extensions that are provided for hot or cold services.



Pipelines must be correctly aligned to ensure that the valve is not fitted under tension.

Fire protection must be provided by the user.

1.6 Spare parts

Use only FLOWSERVE original spare parts. FLOWSERVE cannot accept responsibility for any damages that occur from using spare parts or fastening materials from other manufactures. If FLOWSERVE products (especially sealing materials) have been on store for longer periods check these for corrosion or deterioration before using these products. Fire protection for FLOWSERVE products must be provided by the end user.

1.7 Service / repair

To avoid possible injury to personnel or damage to products, safety terms must be strictly adhered to. Modifying this product, substituting non-factory parts, or using maintenance procedures other than outlined in this instruction could drastically affect performance and be hazardous to personnel and equipment, and may void existing warranties. Between actuator and valve there are moving parts. To avoid injury FLOWSERVE provides pinch-point-protection in the form of cover plates, especially where side-mounted positioners are fitted. If these plates are removed for inspection, service or repair special attention is required. After completing work the cover plates must be refitted.

Apart from the operating instructions and the obligatory accident prevention directives valid in the country of use, all recognised regulations for safety and good engineering practices must be followed.

WARNING:

Before products are returned to FLOWSERVE for repair or service FLOWSERVE must be provided with a certificate which confirms that the product has been decontaminated and is clean. FLOWSERVE will not accept deliveries if a certificate has not been provided (a form can be obtained from FLOWSERVE).



1.8 Storage

In most cases FLOWSERVE products are manufactured from stainless steel. Products not manufactured from stainless steel are provided with an epoxy resin coating. This means that FLOWSERVE products are well protected from corrosion. Nevertheless FLOWSERVE products must be stored adequately in a clean, dry environment. Plastic caps are fitted to protect the flange faces to prevent the ingress of foreign materials. If the positioner must be stored outdoors, it is important that all the cover screws are tightened and that all connections and ports are properly sealed. Replace shipping plugs with proper plugs and do not leave ports open and facing upwards.



1.9 Valve and actuator variations

These instructions cannot claim to cover all details of all possible product variations, nor in particular can they provide information for every possible example of installation, operation or maintenance. This means that the instructions normally include only the directions to be followed by qualified personnel where the product is being used for its defined purpose. If there are any uncertainties in this respect particularly in the event of missing product-related information, clarification must be obtained via the appropriate FLOWSERVE sales office.

2. Unpacking

Each delivery includes a packing slip. When unpacking, check all delivered valves and accessories using this packing slip. Report transport damage to the carrier immediately. In case of discrepancies, contact your nearest FLOWSERVE location.

3. Certificates

Please note that a full copy of certificates and approvals for Intrinsically safe and Explosion proof applications can be downloaded in pdf format from our web page:

<http://www.flowserve.com>

4. APEX 9000 Overview

The **Apex 9000** is a two-wire loop powered, 4-20 mA input digital valve positioner.

The **Apex 9000** positioner controls actuators with rotary mountings.

The **Apex 9000** is completely powered by the 4-20 mA input signal. The minimum input signal required to function is 3,6 mA. As an option the D20 can be equipped with HART protocol to allow bidirectional communication.

Since the positioner is insensitive to supply pressure changes and can handle supply pressures from 1,5 to 6 barg (22 to 105 psig), a supply regulator is usually not required; however, in applications where the supply pressure is higher than the maximum actuator pressure rating a supply regulator is required to lower the pressure to the actuator's maximum rating (not to be confused with operating range). A coalescing air filter is recommended for all applications due to the close tolerances in the positioner.

Apex 9000 positioner accessories: Optional analog feedback system as well as limit switch unit and a directly attachable double acting module.

NOTE: The air supply must conform to ISA 7.0.01 or IEC 770 (a dew point at least 10°C/18°F below ambient temperature, particle size below five microns – one micron recommended – and oil content not to exceed one part per million).



5. Specifications

5.1 Technical data

Input signal	4-20 mA Current supply min.	3,6 mA
Current supply Max.	150 mA	
Load Standard	400 ohm at 20mA Load HART	470 ohm at 20mA
Voltage drop Standard	8 VDC at 20mA Voltage drop HART	9.4 VDC at
20mA Angle of rotation min	0-40°	
Angle of rotation Max	0-90°	
Air supply range	1.5 – 6 bar	
Out put	0-100% of air supply pressure	
Air supply quality	Free from oil, dust and moisture IEC 770, ISA 7.0.01	
Air supply effect	<0.1%FS for 10% pressure change at 6 Bar	
Ingress protection	IP66 / Nema 4X	
Operating humidity	0-100% rh non-condensing	
Air connections	1/4" NPT	
Cable entry	2 x 1/2" NPT or 2 x M20x 1,5	
Terminals	Screw terminals 2,5 mm ² (AWG 14)	
Operating Temperature	-20 to +85°C-40 to +85°C (optional)	
Storage temperature	-40 to +85°C	
Air delivery capacity	7 Nm ³ /h @ 6 bar (3 bar diff pressure)	
Air delivery capacity Double acting	7 Nm ³ /h @ 6 bar (3 bar diff pressure)	
Air consumption Single acting	0,120 Nm ³ /h @ 6 bar	
Air consumption Double acting	0,120 Nm ³ /h @ 6 bar	
Cv air delivery Single acting	0,12	
Cv air delivery Double acting	0,12	
Cut off function	Close 0.5% Open 99.5%	
Linearity	<1%	
Sensitivity	<0.05%	
Resolution	<0,1%	
Repeatability	<0.2%	
Hysteresis + dead band	<0.5%	
Temp effect	<0.1%/10K	
Mounting position effect	<0,2%	
CE	93/68/EEC, 2004/108/EEC, 2006/95/EEC	
Approvals	Ex II G Ex ia IIC T4 Ta: 85°C Class I Division 2 Groups A,B,C,D T4 non-incendive with fieldwiring Class I Division 2 IIC T4 non-incendive with fieldwiring I.S. Class I Division 1 Groups A,B,C,D T4 I.S. Aex ia IIC T4	
Certificate nr	Nemko 08ATEX1362X	
Housing material	Die cast Aluminium	
Surface treatment	Powder coating	
Soft goods	Nitrile	
Weight	1,5 kg (3.0 kg Explosion proof version)	



5.2 Limit switches

Type	SPDT
Size	Sub Sub miniature
Rating	3A, 125 VAC / 2A, 30VDC
Mechanical life	>1 x 10 ⁶ operations

Namur sensors

Type	P+F NJ2 V3 N Inductive DIN 19234
Load current	<1mA>3mA
Voltage range	5-25 VDC
Hysteresis	3-15% (5% typical)
Temp range	-25° to +100° C (-248° to 373° F)

Namur sensors

Type	P+F SJ2-N
Normal Voltage	8 VDC
Load current	1mA<l<3mA
Voltage range	(5-25 VDC)
Hysteresis (max)	0.2%
Temp range	-25° to +100° C (-248° to 373° F)

Namur sensors

Type	P+F SJ2-SN
Normal Voltage	8 VDC
Load current	1mA<l<3mA
Voltage range	5-25 VDC
Hysteresis (max)	(0.2%)
Temp range	-40° to +100° C (-233° to 373° F)

Namur sensors

Type	P+F SJ2-S1N
Normal Voltage	8 VDC
Load current	1mA<l<3mA
Voltage range	5-25 VDC
Hysteresis (max)	0.2%
Temp range	-25° to +100° C (-248° to 373° F)

Proximity switches

Type	SPDT
Rating	10W
Voltage max	200VDC
Current max	500mA
Contact resistance max	0.2 ohm
Operating time	1.0 ms

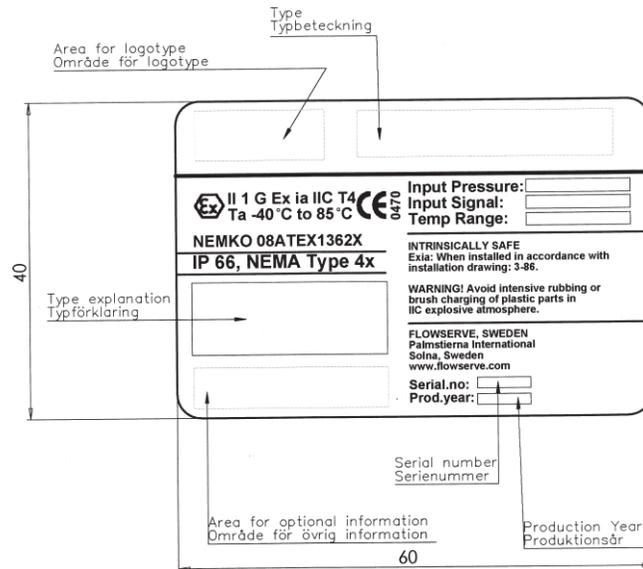
Transmitter

Power supply	12-28 VDC
Output	1-22 mA
Resolution	0.1%
Linearity	±0.5%
Load impedance	600 ohm at (12 VDC and 20mA)

Alarm Output

Supply	3-28 VDC
Output	20mA @ 24 VDC

5.3 Type sign





5.4 APEX 9000 Model Code

- **BRAND**
 - AX – Automax Black Polyester Paint
- **MODEL**
 - 90 – Digital Positioner, Single Button Interface, LED Status
 - 92 – Digital Positioner, Full LCD Menu, LED Status
- **APPROVAL, CERTIFICATIONS**
 - G – General Purpose
 - I – Intrinsically Safe, ATEX/FM
 - N – Class I Division 2, Non-incendive, with Fieldwiring
 - E – Explosionproof, ATEX/FM
- **CONNECTIONS, AIR/ELECTRICAL**
 - M – ¼” NPT Air, M20 x 1.5 Electrical
 - N – ¼” NPT Air, ½” NPT Electrical
- **HOUSING / SURFACE TREATMENT**
 - U – Aluminum, Powder Epoxy, Black
 - R – Remote Mount Feedback Sensor
 - S – Explosionproof, Stainless Steel Enclosure (N Connections Only)
- **FUNCTION**
 - S – Single Acting
 - D – Double Acting, (Note Available on Explosionproof Enclosures) See Note 1
- **SHAFT**
 - 23 – NAMUR, VDI/VDE 3845, Rotary
- **COVER**
 - 1 – Flat Top, All Options (See Note 2) ** Only option for Explosionproof
 - 2 – Dome Indicator, Red/Green, (General Purpose/IS Only) See Note 2
 - 3 – Flat Top, Green/Black Flat Indicator, (General Purpose/IS Only) See Note 2
- **TEMPERATURE / SEALS**
 - Z – Standard Temperature -20°C to 85°C (-4°F to 185°F)
 - Q – Low Temperature -40°C to 85°C (-40°F to 185°F)
- **INPUT SIGNAL / PROTOCOL**
 - N – 4-20mA / None
 - H – 4-20mA / HART
- **FEEDBACK OPTIONS**
 - X – No Feedback Options
 - T – 4-20mA Feedback Transmitter Only
 - S – Switches, Mechanical, SPDT + 4-20mA Transmitter, (See Note 3)
 - N – NAMUR, V3 Type Sensor, P&F NJ2-V3-N + 4-20mA Transmitter, (See Note 3)
 - N – Limit Switches, Proximity, SPDT + 4-20mA Transmitter, (See Note 3)



□ **OPTIONS / ADDITIONAL ELECTRONICS**

- 0 – Standard Diagnostics
- 1 – Advanced Diagnostics, (Available in Model 92 Only)

□ **ACCESSORIES**

- X – No Accessories
- M – Gauge Block, 1/8" G, (2 Gauges Included) See Note 4
- N – Gauge Block, 1/8" NPT, (2 Gauges Included) See Note 4

NOTES:

- 1) If you order double acting, you do not need to order a gauge block. Comes with 2 gauges, Stainless Steel with Brass internals.
- 2) Cover options are valid only for General Purpose, Intrinsically Safe, and Class I Division 2, Non-incendive, (G, I, and N Approvals options).
- 3) Switches are not available in explosionproof enclosure.
- 4) Gauge blocks are only needed for the General Purpose, Intrinsically Safe, and Class I Division 2, Non-incendive options (Approvals G, I and N).

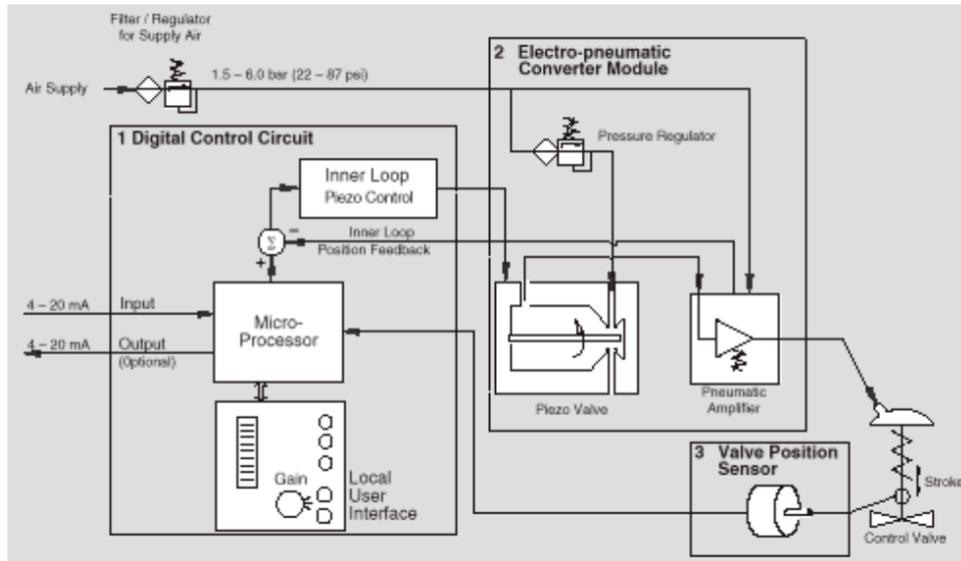


Figure 1

6. Principle of operation

The **APEX 9000** positioner is a digital positioner with various options. The positioner consists of three main modules:

1. The microprocessor-based electronic control module includes direct local user interface switches
2. The piezo valve-based electro- pneumatic converter module
3. The infinite resolution valve position sensor.

The basic positioner operation is best understood by referring to figure 1. The complete control circuit is powered by the two-wire, 4-20 mA command signal. The analog 4-20 mA command is passed to the microprocessor, where it is compared to the measured valve stem position. The control algorithm in the processor performs control calculations and produces an output command to the piezo valve, which drives the pneumatic amplifier. The position of the pilot valve in the pneumatic amplifier is measured and relayed to the inner loop control circuit. This two-stage control provides for more responsive and tighter control than is possible with a single stage control algorithm. The pneumatic amplifier controls the airflow to the actuator. The change of pressure and volume of the air in the actuator causes the valve to stroke. As the valve approaches the desired position, the difference between the commanded position and the measured position becomes smaller and the output to the piezo is decreased. This, in turn, causes the pilot valve to close and the resulting flow to decrease, which slows the actuator movement as it approaches, the new commanded position. When the valve actuator is at the desired position. the pneumatic amplifier output is held at zero, which holds the valve in a constant position.

7. Mounting and installation

7.1 General

Before starting installation, inspect the digital positioner for any transit damages.

After installation, ensure all screw connections are tightened correctly and all moving parts are free from excessive friction.

NOTE!

All products that are covered by an ATEX Certification number ending with an “X”, special care must be taken when cleaning the surface of the product.

“The enclosure must be cleaned with a damp cloth due to static electricity for plastic windows/surfaces”

For securing covers and lids, it’s important to use the correct torque:

Product	Size (screw)	Torque Nm
I/P cover APEX 9000	M4	0,65 Nm +/- 15%
APEX 9000	M5	1,20 Nm +/- 15%
F5EX and XCL / XML / XV	M6 / M8	7 Nm

Covers (thread on) for APEX 9000 EX, D3EX, Tighten fully and secure

Exhaust ports

Apex 9000 exhaust actuator through a hole in the backside, covered by a plate.

Apex 9000 Explosion proof has 2 x exhaust ports, located on the flat areas. Make sure that both these ports are not left open, facing up or side wards.

Protected by a proper bleeder cap or a fitting with short tube ($\geq \text{Ø } 4 \text{ mm}$ inner dia, max 80 mm long) facing downwards



Bleeder cap

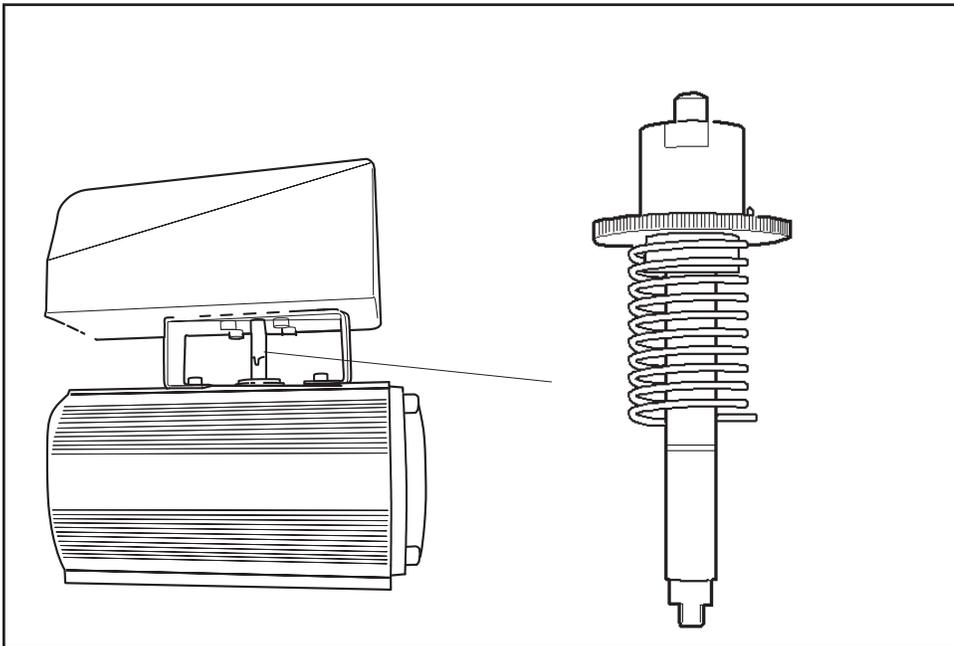
7.3 Mounting

NOTE. If the positioner is installed in a hazardous environment, it must be of a type approved for this purpose.

The Apex 9000 positioner, all versions, has an ISO F05 footprint, A. The holes are used to attach the Apex 9000 to the mounting bracket B. Please contact Flowserve or your local distributor representative with actuator specifics for the proper mounting bracket and hardware.

It is important that the positioner's spindle, that transfer the actuator movements, are correctly mounted. Any tension between these parts can cause incorrect operation and abnormal wear.

Assembly Example:



Rotary actuators

Mounting the Apex 9000 positioner on a quarter-turn actuator (closed or open by spring)

The mounting of a pneumatic double-piston part-turn valve actuator (in accordance with VDI/VDE 3845) is described as an example by using the following equipment:

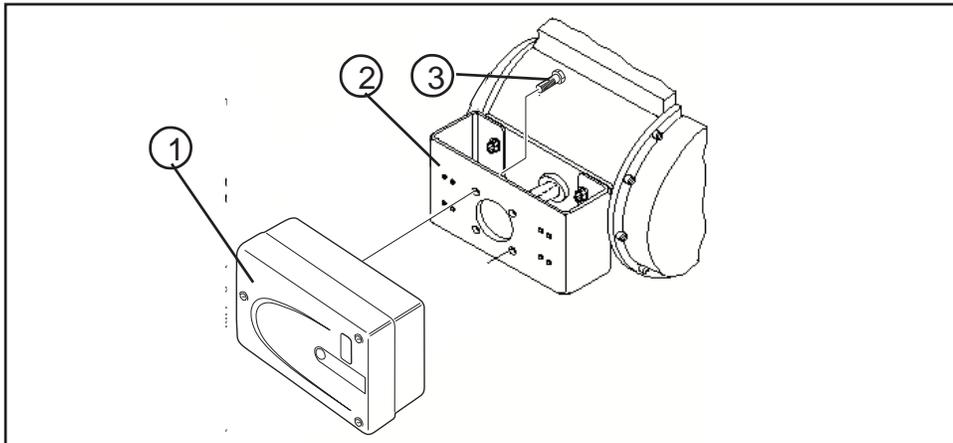
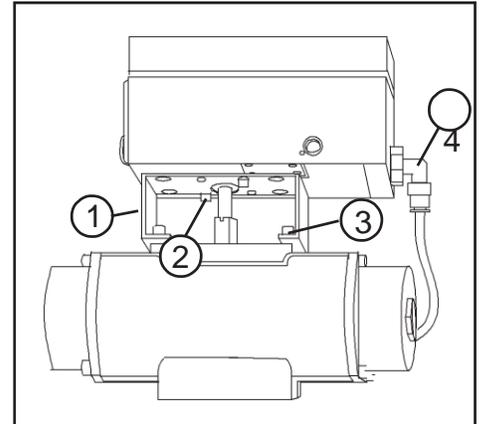
Quarter-turn valve actuator: Rack & pinion or scotch yoke, closed or open by spring.

Rotary actuators VDI/VDE 3485 (NAMUR)

Mount bracket 1 to positioner. Secure with 4 x M6 screws 2.

Fit positioner on actuator and secure with 4 x screws 3.

Install tubing 4 between actuator and positioner.



(Figure 6)

Mounting the positioner

Place the positioner (1) onto the mounting block (2) of the actuator using four screws (3). Ensure the coupler fits on to the shaft of the quarter-turn connection on the part-turn valve actuator.

8. Tubing positioner to actuator

After mounting has been completed, tube the positioner to the actuator using the appropriate compression fitting connectors:

Air connections: 1/4" NPT (standard air connection).

Auxiliary power: Pressurized air or permissible gases, free of moisture and dust in accordance with IEC 770 or ISA 7.0.01.

Pressure range: 1,5 – 6 bar (30 – 90 psi). For connecting the air piping, the following notes should be observed:



1. The positioner passageways are equipped with filters, which remove medium and coarse size dirt from the pressurized air. If necessary, they are easily accessible for cleaning

2. Supply air should meet IEC 770 or ISA 7.0.01 requirements. A coalescing filter should be installed in front of the supply air connection (Figure 8). Now connect the air supply to the filter, which is connected to the **Apex 9000** positioner.

3. With a maximum supply pressure of 6 bar (102 psi) a regulator is not required.

4. With an operating pressure of more than 6 bar (90 psi), a reducing regulator is required.

The flow capacity of the regulator must be larger than the air consumption of the positioner (7 Nm³/h @ 6 bar / 4,12 scfm @ 90 psi).

5. Connect the outlet connector (Figure 7) of the positioner with tubing, independent of the action (direct or reverse). On explosion proof housing air connections are marked S,C+ and C-, plug C- port with proper fitting.

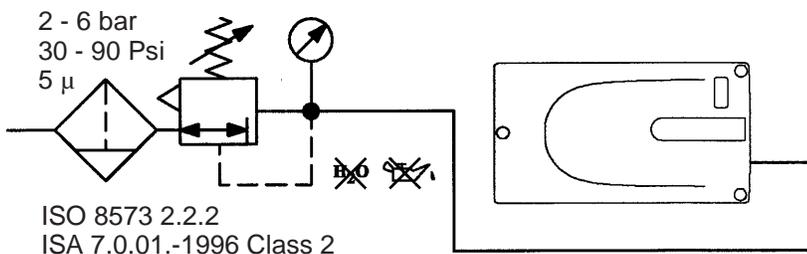


Figure 7

9. Wiring and grounding guidelines

Electrical connections: signal cable with cable passage (1/2" NPT, or M20 x1,5) to terminals 2 x 2,5 mm.

Input signal: 4 – 20 mA

NOTE: Observe the minimum requirements of voltage and equivalent electrical load:

The performance is ensured only for a minimum input current of 3.6 mA
For wiring, the following notes should be observed:

NOTE: The input loop current signal to the **Apex 9000** should be in shielded cable. Shields must be tied to a ground at only one end of the cable to provide a place for environmental electrical noise to be removed from the cable. In general, shield wire should be connected at the source. (Figure 8).

Connect the 4-20 mA current source to terminals +1 and -2, see connection table.

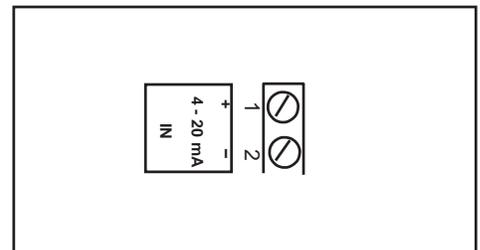


Figure 8 Connections

Connection	Description
+1	Input +4-20 mA
-2	Input -4-20 mA
↑	Pneumatic output signal (outlet)
↓	Air supply



9.1 Grounding screw

The grounding screw, located inside the positioner cover, should be used to provide the unit with an adequate and reliable earth ground reference. This ground should be tied to the same ground as the electrical conduit. Additionally, the electrical conduit should be earth grounded at both ends of its run. The grounded screw must not be used to terminate signal shield wires.

9.2 Electromagnetic compatibility

The **Apex 9000** digital positioner has been designed to operate correctly in electromagnetic (EM) fields found in typical industrial environments. Care should be taken to prevent the positioner from being used in environments with excessively high EM field strengths (greater than 10 V/m). Portable EM devices such as hand-held two-way radios should not be used within 30 cm of the device. Techniques of the control lines, and route control lines away from electro-magnetic sources that may cause unwanted noise.

An electromagnetic line filter can be used to further eliminate noise.

In the event of a severe electrostatic discharge near the positioner, the device should be inspected to ensure correct operability. It may be necessary to recalibrate the **Apex 9000** positioner to restore operation.

Ensure proper wiring and shielding

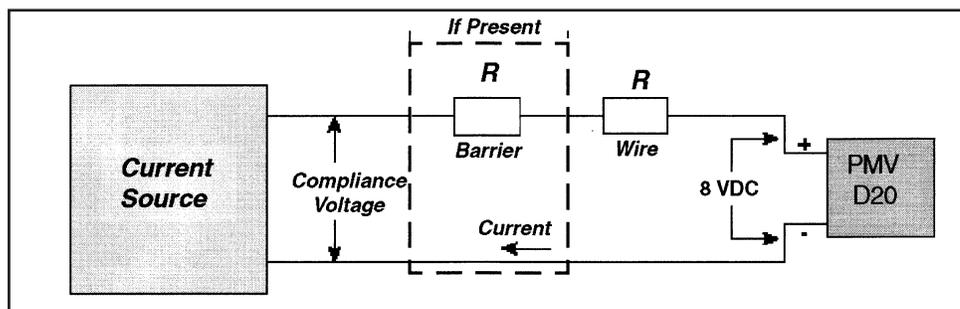


Figure 9. Compliance voltage

9.3 Compliance voltage

Output compliance voltage refers to the voltage limit the current source can provide. A current loop system consists of the current source, wiring resistance, barrier resistance (if present), and the **Apex 9000** impedance.

The **Apex 9000** requires that the current loop system allow for a 8.0 - 9.4 VDC drop across the positioner at maximum loop current.

CAUTION: Never connect a voltage source directly across the positioner terminals. This could cause permanent circuit board damage.

In order to determine if the loop will support the **Apex 9000**, perform the following calculation:

$$\text{Voltage} = \text{Compliance Voltage (@Current}_{\text{max}}) - \text{Current}_{\text{max}}(R_{\text{barrier}} + R_{\text{wire}})$$

To support the **Apex 9000** the calculated voltage must be greater than 9.4 VDC for Apex 9000 HART and 8 VDC for non-HART.

Example: DCS Compliance Voltage = 19 V, $R_{\text{barrier}} = 300\Omega$, $R_{\text{wire}} = 25\Omega$ and $\text{Current}_{\text{max}} = 20\text{mA}$

$$\text{Voltage} = 19\text{V} - 0.020\text{A}(300\Omega + 25\Omega) = \underline{12.5\text{V}}$$

This system will support the **Apex 9000**, as the voltage 12.5 V is greater than the required 8 VDC for non-HART and 9.4 VDC for HART.

10. Operation / Mode 90

10.1 General

The Apex 9000 is operated by the yellow button. Depending on desired action, press the button:

- during a number of seconds (Ex 5 sec):

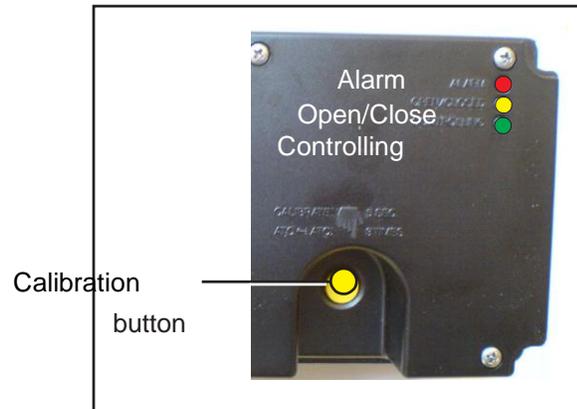
Or

- a number of times. (Ex x3)

10.2 Startup

Connect Air supply and a mA-simulator to the positioner.

 **Warning:** During calibration, the actuator may stroke unexpectedly.



5 sec. Press the button for 5 sec. (Release the button when the three LEDs start to flash alternately).

 The calibration starts, the actuator goes to max. and min. position and calculates the control parameters.

The Calibration procedure will take between 30 seconds and some minutes depending on actuator size. The three LEDs will flash alternately during calibration. After calibration all the three LEDs are lit for a moment.

A successful calibration is indicated by yellow or green LED:

-  Green LED flashes = In service
-  Yellow LED flashes = In service.

The unit vents in max or min position.

An unsuccessful calibration by error codes:
For other indications, see error codes on page 30.

 Apex 9000 does not reach setpoint

10.4 Set Direct or Reverse action

Note! For safety reason, this operation has to be done max 5 minutes after calibration. If time has run out, or if power is disconnected during the five minutes, perform a new calibration, before changing the direction.

Apply 4 mA. If valve is in right position, then check the position over the whole range (8, 12, 16 and 20 mA)

If the direction needs to be changed, press the  calibration button 3 times, and the direction will change.

Check operation at 4 – 8 – 12 – 16 and 20 mA.

10.5 Show gain setting

If the actuator position is unstable or self-oscillating after calibration, the gain can be adjusted. Gain can be set from **A** (lowest) to **G** (highest). Default is **D**.

To **show** the current gain setting, press  the calibration button 4 times.
X4

To indicate the current setting, the LED's flashes according to the following:

- | | | | | |
|-------------|---|---|---|------------------------------|
| | Y | R | R | |
| LED's show: | | | | gain is set to "G" (Highest) |
| | Y | R | Y | |
| LED's show | | | | gain is set to "F" |
| | Y | R | G | |
| LED's show | | | | gain is set to "E" |
| | Y | G | | |
| LED's show | | | | gain is set to "D" (Default) |
| | Y | G | G | |
| LED's show | | | | gain is set to "C" |
| | Y | G | Y | |
| LED's show | | | | gain is set to "B" |
| | Y | G | R | |
| LED's show | | | | gain is set to "A" (Lowest) |

The gain code sequence is repeated 5 times

Button functions:

Press 5 sec = Calibration

Press x3 = Direct/reverse action

Press x4 = Show gain setting

Press x5 - x11 = Change gain setting



To indicate that a command is accepted, the three LED:s light up.

10.6 Change of gain setting

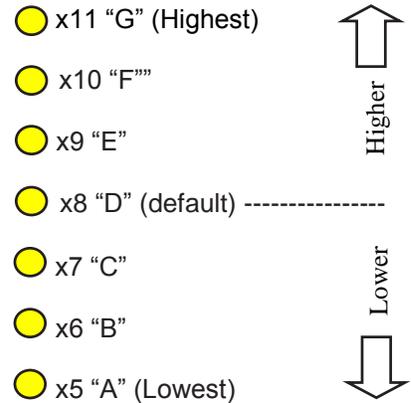
To lower the gain, press the calibration button: 7, 6 or 5 times (5 = lowest)

To increase the gain (if actuator is moving to slow), press the button 9,10 or 11 times (11 = highest) to increase the gain.

The LED's flashes alternately when the button is pressed.
After gain change the LED's show the gain code (see 9.3) five times.

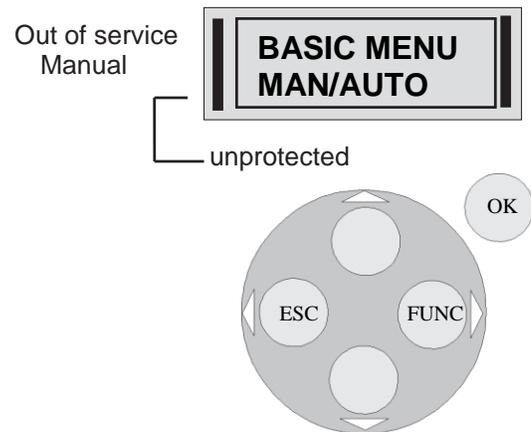
The default value after first calibration is **D** .

After this, setting the gain is complete.



11. Operation / Model 92 with LCD

The positioner is controlled using the five pushbuttons and the display, which are accessible when the aluminium cover is removed



Use the  pushbuttons to browse through the menus and sub-menus.

The main menu is divided up into a basic menu and a full menu, see page 21.

11.2 Other functions

ESC

Exit the menu without making any changes (as long as any changes have not been confirmed with OK).

FUNC

To select function and change parameters.

OK

To confirm selection or change of para-meters.

MENU INDICATOR

Displays the position of the current menu row in the menu.

IN SERVICE

The positioner is following the input sig-nal. This is the normal status when the positioner is working.

OUT OF SERVICE

The positioner is not following the input signal. Critical parameters can be changed.

MANUAL

The positioner can be adjusted manually using the pushbuttons. See section "Man/Auto", page 24".

UNPROTECTED

Most of the parameters can be changed when the positioner is in the "Unprotected" position. However, critical parameters are locked when the positioner is in the "In service" position.

11.3 Menu indicator

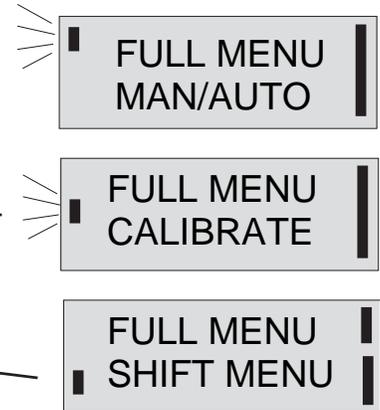
There are indicators at both sides of the display window and they indicate as follows:

Flashing in position **Out of Service**

Flashing in position **Manual**

Flashing in position **Unprotected**

The indicators on the right-hand side show the position in the current menu.



11.4 Menus

To display the menus you can select:

- **Basic menu**, which means you can browse through four different steps
- **Full menu**, which comprises ten steps. Use the Shift Menu to browse through the steps

Full Menu can be locked out using a passcode.

The main menus are shown on the next page and the sub-menus on the subsequent pages.

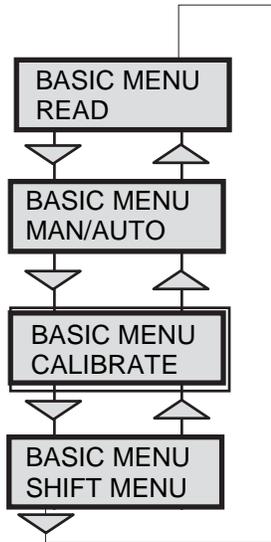
11.5 Changing parameter values

Change by pressing  until the desired figure is flashing.

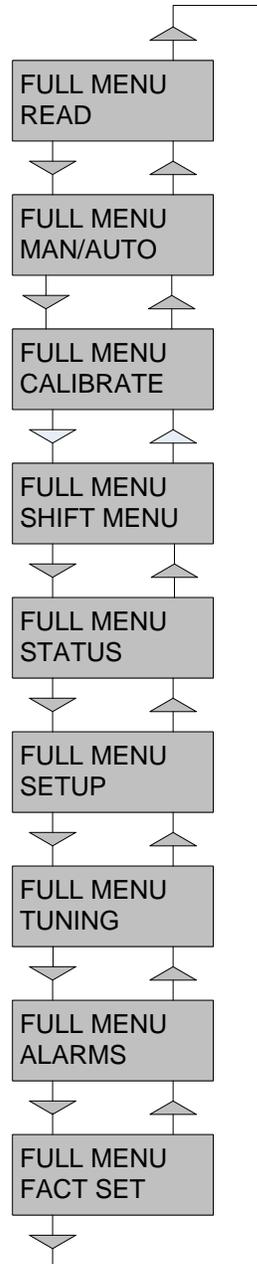
Press  to step to the desired figure. Confirm by pressing OK.

A change can be undone by pressing the **ESC** button, which returns you to the previous menu.

11.6 Menu system



The menus are described on the following pages.





11.7 First start

Calibrate in the basic menu is displayed automatically the first time the power is applied, and can be selected from the basic/main menu at any later time.

A complete auto-calibration takes about 2 minutes and includes end limit calibration, auto-tuning and a check on the speed of movement. Start the automatic calibration by selecting **Auto-Cal** and then answer the questions on the display by pressing **OK** or the respective arrow. The menu is described on the next page.

Calibration error messages

If a fault occurs during calibration, one of the following error messages can be displayed:

No movement/press ESC to abort Typically the result of an air delivery issue to the actuator, or incorrect mounting and/or linkage arrangement. Check for proper supply air to the positioner, pinched tubing, proper actuator sizing, proper linkage and mounting arrangement.

Pot un-calibrated/press ESC to abort The potentiometer has been set to an illegal value. The potentiometer is aligned using the Calibrate - Expert cal - pot Menu. The calibration sequence must be restarted after the fault is corrected.



The contents of the menu are shown on the next page. The various menu texts are described below.

<p><u>Auto-Cal</u> Start tune</p>	<p><u>Auto-tuning and calibration of end positions</u> Starts the tuning. Questions/commands are displayed during calibration. Select the type of movement, function, etc. with  and confirm with OK as shown in the chart on the next page.</p>
<p>Lose prev value? OK? Direction? Air to open/ Air to close</p>	<p>A warning that the value set previously will be lost (not during the first auto-tuning). Select action on C+ increasing</p>
<p>In service? Press OK</p>	<p>Calibration finished. Press OK to start positioner functioning. (If ESC is pressed, the positioner assumes the "Out of service" position but the calibration is retained).</p>
<p><u>TravelCal</u> Start cal</p>	<p><u>Calibration of end positions</u> Start end position calibration.</p>



- Lose prev value? OK?** A warning that the previously set value will be lost.
Confirm with OK.
The calibration sequence starts
- In service? Press OK** Calibration finished. Press OK to start positioner functioning. (If ESC is pressed, the positioner assumes the "Out of service" position but the calibration is retained).

Perform

Setting gain

Normal A,B,C,D,E,F,G See Page 17 for details on how to set gain.

ExpertCal

Set point LO: Use the calibrator set to 4 Ma (or set another value on the display). Press OK.

Set point HI: Use a calibrator of 20 mA (or set another value on the display). Press OK.

Transmitter: Connect 10 - 28VDC. Connect an external mA meter to the loop. Read low value on mA meter and adjust with up/down key. Press OK to set low value. Repeat procedure to set High value. Also see video on www.flowserve.com

Pot: Potentiometer setting, see section 8. Also see video on www.flowserve.com

Full reset: Resets all set values.

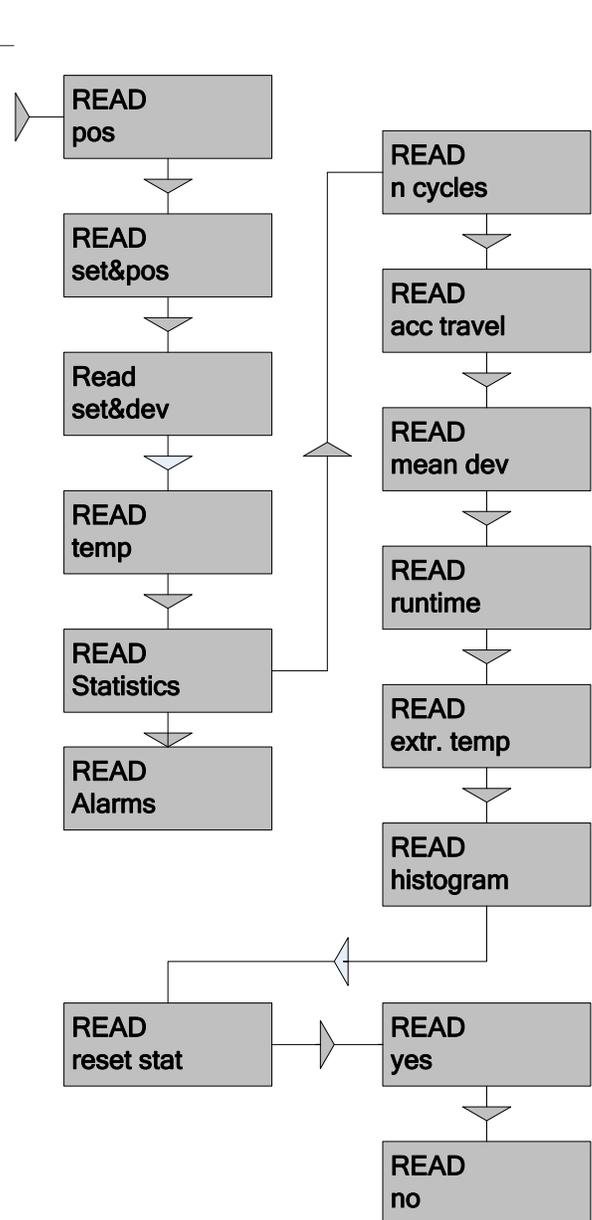
Optional

Pressure LO: Use a supply of 2 bar (30 psi) (or set another value on the display). Press OK. Pressure read out only possible on Apex 9000 with built in pressure sensor.

Pressure HI: Use a supply of 7 bar (105 psi) (or set another value on the display). Press OK. Pressure read out only possible on Apex 9000 with built in pressure sensor.

The menu contents are shown in the figures on the right and the texts are described below:

	Basic Menu Read	
<u>Pos</u>	Shows current position	
<u>Set&pos</u>	Set point and position	
<u>Set&dev</u>	Set point and deviation	
<u>Temp</u>	Shows current temperature	
<u>Statistics</u>		
n cycles	Shows number of movements (turns)	
Acc travel	Shows accumulated movement	
mean dev	Shows accumulated deviation (absolute values) in %	
# of reset	Shows number of resets	
runtime	Shows accumulated runtime since last reset	
Extr temp	Shows extreme min and max temperature	
Histogram	Shows position and time for PV	
<u>Alarms</u>	Displays tripped alarms	
# of resets	Number of Resets	
Reset stat	Resets Statistics	
PosGraph	Shows position with graph	





The Man/Auto menu is used to change between manual and automatic modes.

The menu contents are shown in the figures on the right and the various texts are described below:

AUT, OK = MAN

Positioner in automatic mode

MAN, OK = AUT

Positioner in manual mode



When changing between **MAN** and **AUT** mode, the **OK** button must be pressed for 3 seconds.

In the **MAN** mode, the value of POS can be changed using . The push- buttons increase/decrease the value in steps. The value can also be changed in the same way as for the other parameter values, as described on page 20.

Other functions

C+ can be fully opened by pressing and then immediately OK simultaneously.

C+ can be fully opened for blowing clean by pressing and OK simultaneously.

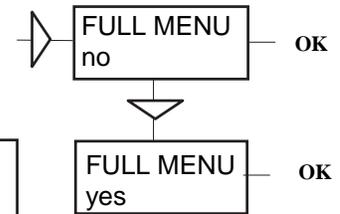


The Shift Menu is used to choose between the basic menu and the full menu.

The menu contents are shown in the figures on the right and the various texts are described below:

- No Full menu selected.
- Yes Basic menu selected.

Full Menu can be locked with a passcode, see Setup menu.





The Status Menu is used to select whether or not the positioner is in service.

The menu contents are shown in the figures on the right and the various texts are described below:

- o o service** Not in service.
Flashing indicator in upper left-hand corner of display.
- in service** Positioner in service.
Critical parameters cannot be changed.



The Setup Menu is used for various settings.

The menu contents are shown in the chart on the next page and the various texts are described below:

<u>Actuator</u>	<u>Type of actuator</u>	<u>Size of actuator</u>	<u>Time out</u>
Rotating	Rotating actuator.	Small	10 s
Linear	Linear actuator.	Medium	25 s
		Large	60 s
		Extra Large	180 s

Lever Only for linear actuator.
Lever stroke Stroke length to achieve correct display.
Level cal Calibration of positions to achieve correct display.

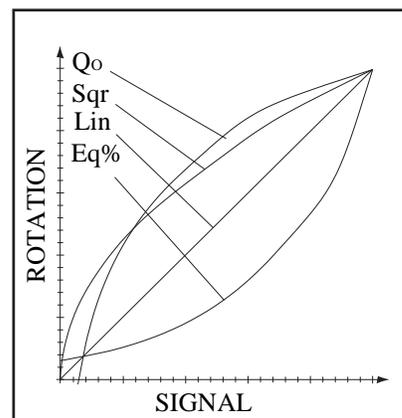
Direction

- Direct** Direct function (signal increase opens). Indicator/spindle rotates counter-clockwise.
- Reverse** Reverse function.

Character Curves that show position as a function of input signal.

- Linear** |
- Equal %** | See Diagram
- Quick Open** |
- Square Root** |
- Custom** Create Own Curve

Custom Characterization # of points (Specify # of pts, 3,5,9,17 or 33)
Custom Curve: Enter values on X and Y axis.
Current Range: 0%=4mA, 100%= 20mA
 Possibility of selecting which input signals correspond to 0% and 100% movement respectively. Examples of settings: 4mA = 0%, 12mA = 100%, 12mA = 0%, 20mA = 100%





TRVL range 0%=0.0%	<u>Setting end positions</u> Select Out of Service. Set percentage value for desired end position (e.g. 3%).
Set 0%	Select In Service. Connect calibrator. Move forward to desired end position (0%) and press OK.
100%=100.0%	Select Out of Service. Set percentage value for desired end position (e.g. 97%).
Set 100%	Select In Service. Connect calibrator. Move forward to desired end position (100%) and press OK.
Trvl ctrl Set low	<u>Behavior at set end position</u> Choose between Free (go to mechanical stop), Limit (stop at set end position), and Cut off (go directly to mechanical stop at set end position).
Set high Values	Similar to Set low. Select position for Cut off and Limit at the respective end positions.
Passcodes Full menu Write prot Expert Fact set	<u>Setting passcodes for various functions</u> Passcode for access to full menu. Passcode for removing write protect. Passcode for access to Expert menu (TUNING). Passcode to return to default values applicable when positioner was delivered.
Numbers between 0000 and 9999 can be used.	
Appearance Language Units	<u>On display</u> Select menu language. Select units.
Def. Display	Select value(s) to be displayed during service. The display reverts to this value 10 minutes after any change is made.
Start menu	Start in Basic menu or Full menu.
Start Logo	Shows Flowserve Logo
Orient	Orientation of text on display.
Devicedata HW rev SW rev Capability	— General Parameters
HART	Menu with HART parameters. Only amendable with HART communicator. It is possible to read from display.



The menu contents are shown in the chart on the next page and the various texts are described below:

<u>Close time</u>	<u>Minimum time (Min 0.005) from fully open to closed.</u>
<u>Open time</u>	<u>Minimum time (Min 0.05) from closed to fully open.</u>
<u>Deadband</u>	<u>Setting deadband. Min. 0.2%.</u>
<u>Expert Control</u>	<u>Advanced settings.</u> See explanations below.
Togglestep	Test tool for checking functions. Overlays a square wave on the set value.
Self test	Internal test of processor, potentiometer, etc.



Leakage Air leakage in actuator/tubing can be compensated by settings.

Undo You can read last 20 changes.

P,I,D and K,Ti,Td parameters

If one of the gains is changed, the corresponding value in the other gain set is changed accordingly.

Spring adjust

The spring adjust function compensates the airflow linearly with the actuator C+ chamber volume (for a constant position error), so that low volumes get less flow. This is needed for linear single-acting actuators, where a low C+ volume means that the actuator spring is extended, its force is reduced, and less flow is needed for stable position change.

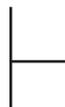
Fiction

High or Low: Select High for high friction valve actuator assemblies such as plug valves



- Deviation** Alarm generated when deviation occurs
- On/Off** Alarm on/off.
- Distance** Allowed distance before alarm is generated.
- Time** Total deviation time before alarm is generated.
- Alarm out** Select ON/OFF offers output on terminals.
- Valve act** Behaviour of valve when alarm is generated.

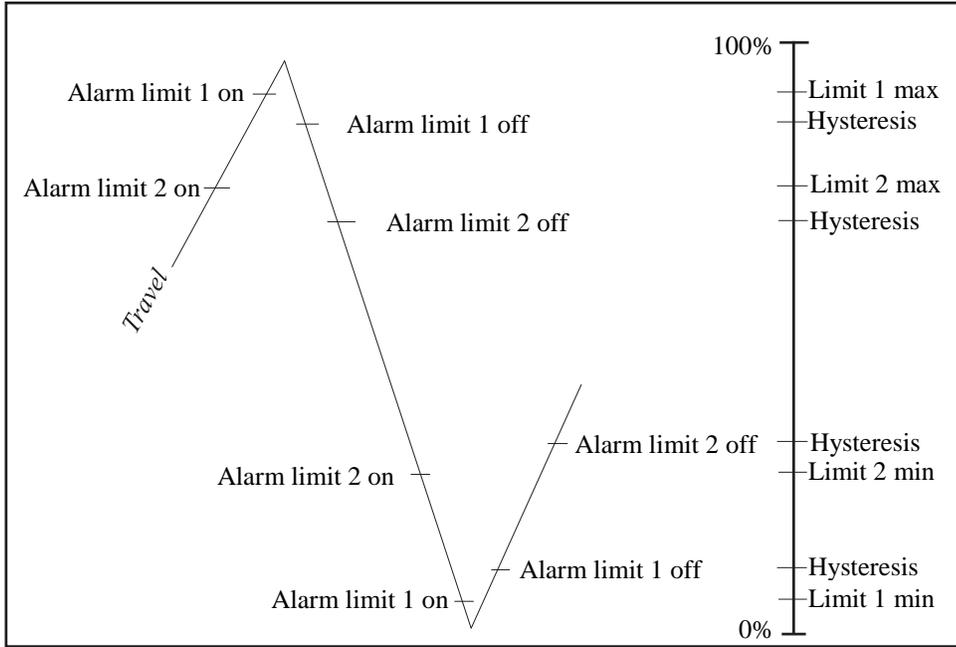
- Limit 1** Alarm above/below a certain level.
- On/Off** Alarm on/off.
- Minipos** Setting of desired min. position
- Maxpos** Setting of desired max. position
- Hysteresis** Desired hysteresis.
- Alarm on** Select ON/OFF offers output on terminals.
- Valve act** Behaviour of valve when alarm is generated



See Diagram Below!

Limit 2

See Limit 1.



temp

On/Off

Low temp

High temp

Hysteresis

Alarm on

Valve act

Alarm based on temperature.

Temperature alarm on/off.

Temperature low limit setting

Temperature high limit setting

Allowed hysteresis.

Select ON/OFF offers output on terminals.

Behaviour of valve when alarm is generated

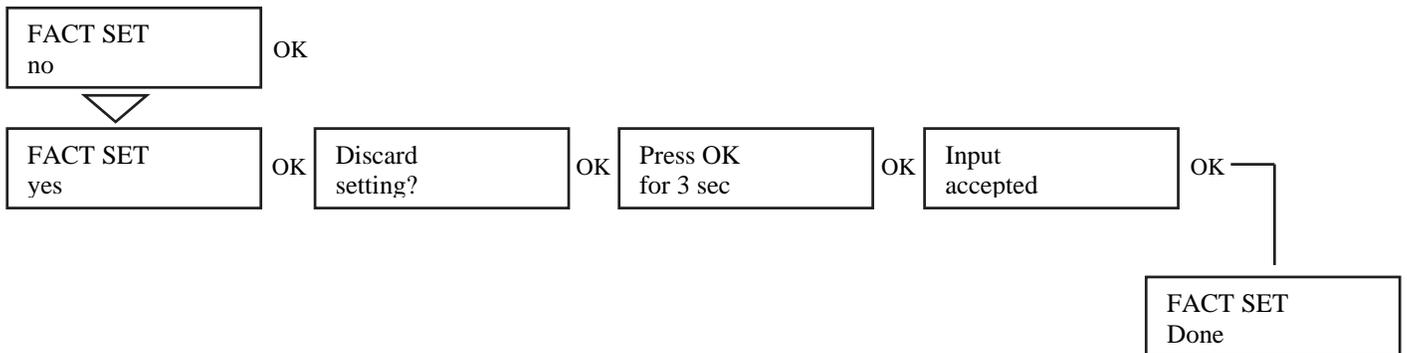
Valve act

- No action** Alarm generated only. Operations no affected.
- Goto open** C+ gives full pressure and valve moves to fully open position. Positioner changes to position Manual.
- Goto close** C- gives full pressure and valve moves to fully closed position. Positioner changes to position Manual.
- Manual** Valve stays in unchanged position. Positioner moves to position Manual.



The menu contents are shown in the chart below.

The default values that were set on delivery can be reset using the Fact Set menu. Values from calibration and from other settings will then be lost.





READ

MAN/AUTO		AUTO.OK = MAN MAN.OK = AUTO		G	pos			
CALIBRATE	Autocal			F	set&pos			
	Travelcal			E	set&dev	Pressure **	Supply	n cycles
	Perform			D	Pos Graph		C+	acc travel
	Expertcal			C	temp			mean dev
SHIFT MENU			Setpoint	B	statistics			m. abs dev
	Basic menu		Pressure	A	alarms			runtime
	Full menu		transm. pot full reset	normal				# of reset extr temp histogram reset stat
STATUS	O O SERVICE							
	IN SERVICE							
SETUP	Actuator	type	rotary	single act	small			
		function	linear	double act	medium			
	size				large			
	Lever (*)	Stroke	direct		linear			
	Direction	Lever cal	reverse		equal %			
	Character				quick open			
	Cust chr				custom			# of points
					sqr root			XO=
	Curr range	0% =	0% =					Custom curve
		100%=	Set 0%					YO=
	Trvl range		100% =					
			Set 100%					
	Trvl ctrl	Set low	free		Cutoff low	Direction	direct	
		Set high	cutoff		Cutoff hi		reverse	
		Values	limited		Limit Low	Pos/Set	Position	
	Transm.				Limit Hi		Set Point	
	Passcodes	old	new (0=off)		Trans. Card			
	Apperance	Language	English				D3-38	
			Svenska				D3-81	
			Deutsch	percent				
			francais	mA				
			Italiano	mm	percent			
			espanol	cm	mm			
		Units	Setpoint	inch	cm	bar		
			Position	degrees	inch	psi	Grad C	
			Pressure **		degrees	kPa	Grad F	
			Temp				Kelvin	
		Def. Displ						
		Start menu						
		Start Logo		Last value	pos	Messages		
				basic	set&pos	Tag		
				full	set&dev	Descriptor		
		Orient.	On/off		menu	Date		
			normal.			Device ID		
			flipped.		HW rev	Poll adr		
	Devicedata				SW rev	Assemblyno		
					Capability	univ cmd		Pos (PV)
					HART	spec cmd	On/off	Set (SV)
						Burst	burst mode	4 Dynamic
TUNING	Close	Control	(X)	P.I.D.	none			
	Open time	Togglestep		K, Ti, Td.	medium			
	Deadband	Selftest		Spring adj	strong	low		runtime
	Expert	Undo		Friction		high		cycletime
		leakage						size
								start
								Abort step
ALARMS	Deviation							
	Limit 1	On/off	On/off	On/off				
	Limit 2	Min pos	Low temp	Distance				
		Max pos	High temp	Time				
	Hysteresis	Hysteresis	Alarm out	Valve act				
	Alarm out	Alarm out						
	Valve act	Valve act						no action
	Temp							goto open
								goto close
								manual
FACT SET	no							
	yes							

(*) appear if Linear is set
 (**) appear if pressure sensors exist
 (X) Position is shown in upper row (PID, kTiTd)



12. Limit switches & 4 - 20 mA transmitter (Optional)

Caution!

The installation of electrical equipment in hazardous areas must comply with the procedures contained in the certificates of conformity. Country specific regulations may apply.

Electrical safety is determined only by the power supply device.

12.1 General

Apex 9000 can be equipped with optional plug in modules for limit switches and/or 4-20 mA feedback transmitter.

12.2 Model selection

See Apex 9000 model code

12.3 Principle of operation

The stroke of the actuator/valve is picked up by the potentiometer inside the Apex 9000. Movement is transferred from actuator via lever or shaft coupling. Cams/vanes mounted on the positioner shaft actuate limit switches 1 and 2. The switching point can be adjusted on each cam/vane.

The position transmitter converts actual position into a 4-20mA output signal. This loop requires an external 12-25 VDC power supply.

12.4 Installation



Caution! Turn off power and air supply before starting the installation.

Important!

For Apex 9000 installed in hazardous areas, maintenance and repair must only be made by authorized and trained staff.



- Remove cover, indicator if present and inner plastic cover.
- Check that spacers are installed on the printed circuit board.
- Carefully install feedback board into its position on the pins.
- Secure it with two (2) screws.



-Install cam assembly on the shaft, if feedback card has mechanical micro switches, be careful to not damage switch arms.

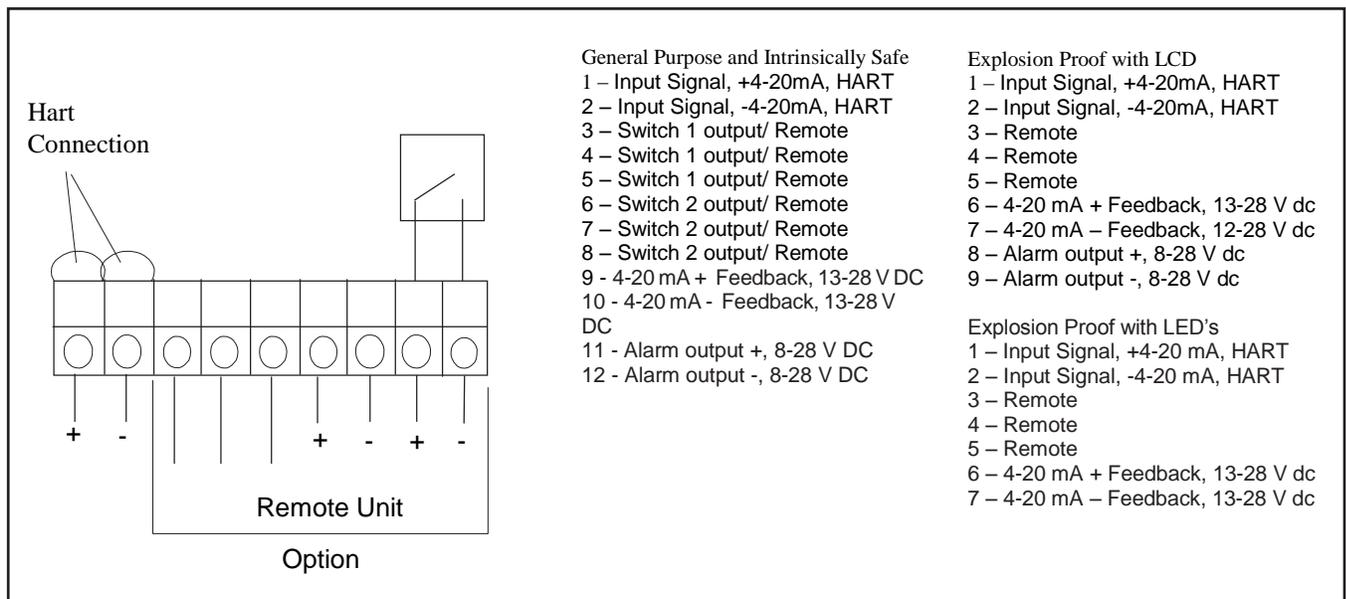
-Install plastic inner cover.

-Adjust cams/vanes to ensure proper switching.

-Secure cam/van position by locking them with two (2) screws.

-Calibrate 4-20 mA transmitter, (see next page).

-Install cover



12.5 Apex 9000 Calibration of 4-20 mA input signal and/or 4-20mA feedback transmitter

• Press and hold button while switching on power to the Apex 9000, keep the button pressed for 6 sec. The eeprom will now be erased, and then all three LEDs are lighted. The LEDs will start to flash yellow-red. This starts FACTORY MODE!

To calibrate 4-20 mA input signal

• Apply 4.0 mA input signal and then push the button three (3) times until all LEDs are lighted. The LEDs will now start flash yellow-red again.

Apply 20.0 mA input signal and then push the button three (3) times until all LEDs are lighted.

To calibrate 4-20 mA transmitter output signal

Note! If no transmitter board is installed the LEDs will start flash yellow-yellow and the unit is ready for continued calibration. If there is a transmitter board installed the LEDs will start flash yellow-green.

The feedback transmitter output signal on pin 9 and 10 will now follow the input signal instead of the position. Apply 4.0 mA input signal. Measure the output signal and adjust the input signal up/down until the output signal is 4.0 mA. Push the button three times until all LEDs are lighted. The unit will now start to flash yellow-green again.



The output signal on pin 9 and 10 will continue to follow the input signal instead of the position. Apply 20.0 mA input signal. Measure the output signal and adjust the input signal up/down until the output signal is 20.0 mA. Push the button three times until all LEDs are lighted.

The LEDs will start flash yellow-yellow and the unit is ready for continued calibration.

Press the button for 5 sec until the LEDs start alternating, Apex 9000 starts to calibrate stroke.

After calibration the unit will start running in normal operation.

13. Trouble shooting

13.1 Apex 9000 Normal operation

G 	Normal operation.	
Y 	Valve fully closed or open "Cut off" enabled.	

13.2 Calibration

R G  (No movement)	No air supply or shaft do not move.	Check air supply Check shaft movement.
R Y G 	Pot not calibrated.	Calibrate the pot.
R G R 	Hallsensor value too low.	
R R G 	Hallsensor span too low.	Check hallsensor connection.
R Y R 	Hallsensor value too high.	
Y R 	Unit in Factory Mode.	Calibrate 4 - 20 mA input signal.
Y G 	4 - 20 mA feedback installed.	Calibrate output.



13.3 APEX 9000 symptoms and solutions

Failure	Probable Cause	Corrective action
No LED is flashing.	Current source below 3,6 mA . Incorrect wiring polarity.	Verify current source supplies at least 3,6 mA. Check wiring for correct polarity.
Valve position reading is not what is expected.	Stem position sensor mounting is off 180 degrees. Apex 9000 not calibrated. Tight shutoff MPC (Minimum position cutoff) is active.	Reposition sensor. Calibrate Apex 9000. No action.
Apex 9000 goes in wrong direction.		Change direction (Section 10.4).
Apex 9000 is oscillating.		Decrease gain (Section 10.6).
Apex 9000 is responding slow.		Increase gain (Section 10.6).

14. Maintenance/service

When carrying out service, replacing a circuit board, etc., it may be necessary to remove and refit various parts of the positioner. This is described on the following pages.

Read the Safety Instructions on page 3 before starting work on the positioner. Cleanliness is essential when working with the positioner. Contamination in the air ducts will infallible lead to operational disturbances. Do not disassemble the unit more than that described here.

Do not take the valve block apart because its function will be impaired.

When working with the Apex 9000 positioner, the work place must be equipped with ESD protection before the work is started.



Always turn off the air and electrical supplies before starting any work.

When upgrading electronically parts inside a Automax positioner approved for installation in Hazardous locations special procedures apply, permission from Automax/Flowserve is required prior to the start of work.

Please contact a Flowserve office for information regarding proper procedures.

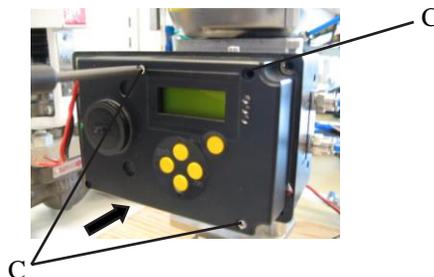
Disassembling Apex 9000

Removing cover and inner cover

- Loosen and remove the screws A and remove the cover. When mounting cover – see page 10.



- Pull off the arrow pointer, B, using a small screw driver.



- Remove the screws C, pull the inner cover slightly in the direction of the arrow, and remove the cover. Do not remove the filter plug.

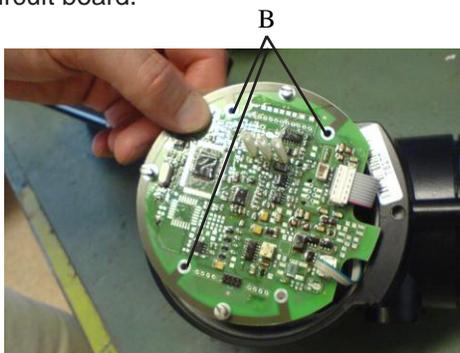
Disassembling Apex 9000 Explosion Proof

Removing cover and inner cover

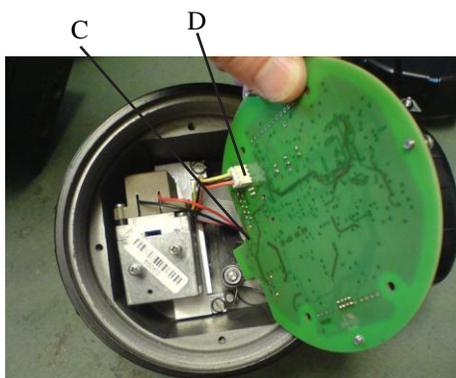
- Unscrew the screw A and remove the cover. When mounting cover – see page 10.



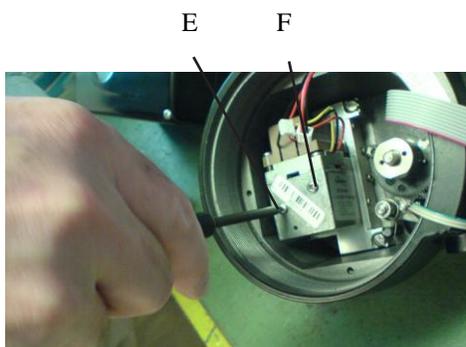
- Unscrew the three screws B, lift the circuit board.



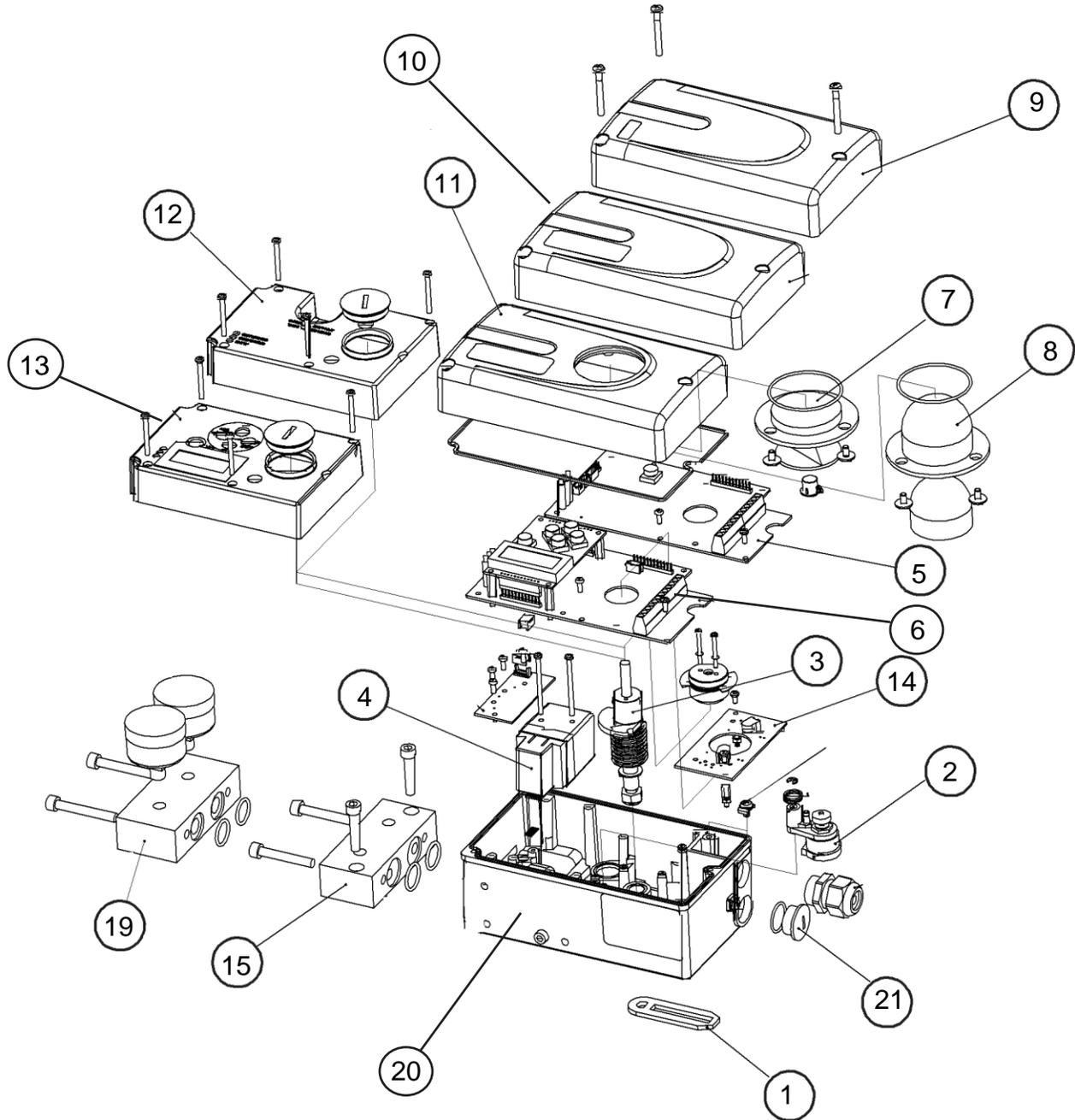
- Loosen the cables C and D.



- Unscrew the two screws E and F and remove the Modulator.



15. Spare parts: General Purpose/IS/non-incendive Enclosures

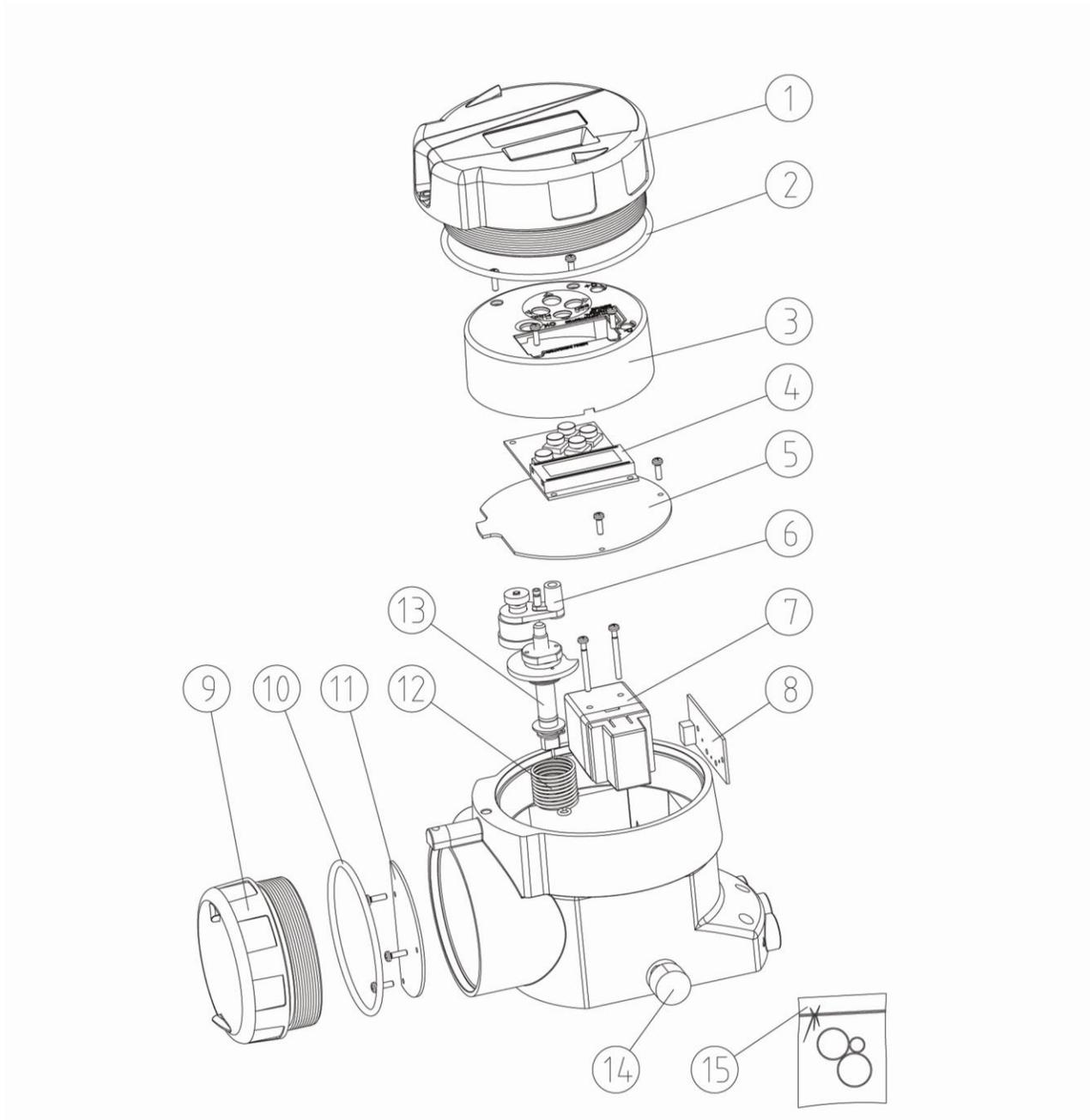




For Intrinsically Safe/ General Purpose/non-incendive

Item #	Part Number	Description	Remarks
20	X05058	Housing	N/A as part
1	X05012	Lever arm set	
2	X05013	Potentiometer assy. Complete	
3	X05014	Shaft, VDI/VDE 3845 Rotary	
4	X05015	Air relay assy. Ind. O-rings, screws, standard temp	
4	X05016	Air relay assy. Ind. O-rings, screws, low temp	
5	X05017	Electronics	
5	X05018	Electronics, Intrinsically Safe	Ex ia
5	X05019	Electronics, HART	HART
5	X05020	Electronics, HART, Intrinsically Safe	Ex ia, HART
6	X05021	Electronics (For LCD Apex 92)	
6	X05022	Electronics Intrinsically Safe (For Apex 92)	Ex ia
6	X05023	Electronics, HART (For Apex 92)	HART
6	X05024	Electronics, HART Intrinsically Safe (For Apex 92)	Ex ia,HART
7	X05025	Indicator, flat assy, Complete	
8	X05026	Indicator, dome style assy. Complete	
9	X05027	Front cover, no indicator, black, ind. Screws	
10	X05028	Front cover w/ LCD, no indicator, black, ind. Screws	
	X05029	Front cover, for indicator/dome, black, ind. Screws	
11	X05030	Front cover w/, for indicator/dome, black, ind. Screws	
12	X05031	Inner cover assy.	
13	X05032	Inner cover assy, LCD version	
14	X05033	4-20mA transmitter only	
14	X05034	Mechanical switches assy. Comp (incl. cams, screws)	
14	X05035	Proximity switches assy. Complete	
14	X05036	P&F NJ2-V3-N sensor assy. Complete	
14	X05037	P&F SJ2 S1N sensor assy. Complete	
14	X05038	P&F SJ2 SN sensor assy. Complete	
14	X05039	P&F SJ2N sensor assy. Complete	
19	X05040	Gauge block B 1/4, NPT, 1/4" NPT, 1/8" NPT, no gauges	
19	X05040	Gauge block B 1/4, NPT, 1/4" NPT, 1/8" NPT, 1 Gauge (SS/Brass)	
19	X05040	Gauge block B 1/4, NPT, 1/4" NPT, 1/8"NPT, 2 Gauges (SS/Brass)	
15	X05041	Double acting module incl. 2 gauges	
21	X05042	Plug and cable gland kit, black	
	X05043	Seal and O-ring kit	
	X05044	Screw and washer kit	

16. Spare Parts: Explosion Proof Enclosure





For Explosion Proof Version Apex 90 and 92

Item#	Part Number	Description	Remarks
		Housing	N/A as part
1	X05045	Cover, large	N/A as part
9	X05046	Cover, terminals	N/A as part
6	X05047	Potentiometer complete, including spring, holder, cable	
13	X05048	Shaft, VDI/VDE 3845 Rotary	
7	X05049	Air relay, Ind. O-rings, screws, standard temp	
7	X05050	Air Relay, Ind. O-rings, screws, low temp version	
5	X05051	Electronics, single button Apex 90 ver.	
5	X05052	Electronics + 4-20 mA transmitter, Single button Apex 90 ver.	HART
5	X05053	Electronics, HART, Single button Apex 90 ver.	HART
5	X05054	Electronics, HART+4-20 mA transmitter, Single button Apex 90 ver.	
4	X05055	Electronics, For LCD, Apex 92 ver.	
4	X05056	Electronics + 4-20 mA transmitter for LCD, Apex 92 ver.	
4	X05057	Electronics, HART for LCD, Apex 92 ver.	



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