

Apex 4000 Positioner

Principles of Operation:

The Apex 4000 positioner causes rotation (or linear movement) of valve actuator in proportion to an input signal. This signal may take the form of pneumatic pressure (Model 4000) or electric current (Models 4100, 4200, 4300 and 4400). Supply pressure is directed to the actuator through a precision spool valve. As input pressure is varied, the balance beam shifts away from its neutral position. The spool also shifts and a differential pressure is created across the actuator causing rotation (or linear movement). Actuator motion is fed back through the positioner shaft and cam. Cam rotation causes movement of the feedback arm, changing compression in the feedback spring, forcing the balance beam and spool back to their neutral positions. This shuts off the flow of air to the actuator and rotation stops.

Installation:

The Apex 4000 positioner can be installed on rotary and linear actuators. Actuators can be either double acting or spring return. Positioners can be set up for rotation in either direction (direct or reverse acting).

Supply Air Requirements: Air pressure must be limited to 150 psi for supply and 30 psi for instrument signal to avoid damage to the positioner. Supply air must be clean, dry, and oil free instrument quality air in accordance with ISA S7.3 specifications (dew point >18 degrees below ambient temperature, particle size <5 microns, oil content <1ppm).

Before making pneumatic connections to the positioner, it is recommended that the supply air lines are opened up and allowed to vent for 2-3 minutes to clear any debris from the line. If excessive amounts of oil and/or moisture are present, the plant air supply should be evaluated to reduce possibility of premature positioner failure.

Mounting: The following instructions apply to rotary actuators only. Linear applications require special mounting and coupling (consult factory).

1. Mount bracket to actuator. Tighten bolts finger tight only at this time. A standard bracket is available for mounting to NAMUR compliant actuators.
2. Install coupler (not required if installing to a NAMUR compliant actuator) on actuator shaft making sure it is centered.
3. Verify that orientation of actuator (and coupler) flats match positioner shaft flats. If necessary, rotate the cam before installing positioner (see "Cam Installation").
Note: *Actuator should be in orientation corresponding to zero input signal.*

4. Install positioner onto bracket. Make sure positioner shaft and coupler are engaged and centered. Tighten bolts finger tight only at this time.

Pneumatic Connections: All pneumatic connections, the supply, both output ports, and the instrument ports are female 1/4" NPT. All connections require user-supplied tubing fittings. **Caution:** *Do not use Teflon tape as a pipe thread sealant. Use only a liquid or paste non-hardening pipe sealant on the threads.*

5. Connect positioner ports C1 and C2 to actuator. Port C2 is **always** connected to the actuator port used to drive actuator away from its start or fail position (the factory cam setting is full clockwise at minimum input). Port C1 is connected to the opposite port or may be plugged for spring return actuators. **Note:** *For fail counterclockwise applications, the cam must be flipped over so the "R" side is facing upwards (see "Cam Installation").*
6. Connect supply air to the port marked "S".
7. Connect instrument signal air to the port marked "I" for model 4000. For models 4100, 4200, 4300 or 4400, connect 4-20 mA and ground (-). For intrinsically-safe applications (Model 4400 only), see separate intrinsically-safe I-P IOM for barrier requirements and schematics. The I-P is factory calibrated and cannot be adjusted.
8. Stroke actuator/valve two or three times to align positioner, coupler and actuator. With 50% input (actuator/valve at 45 degrees), tighten all mounting bolts. Stroke actuator/valve again to verify there is no misalignment throughout stroke.

Calibration:

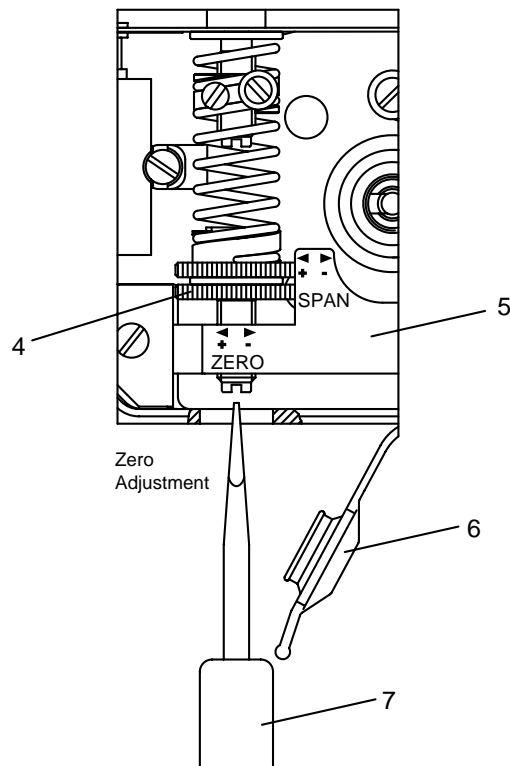
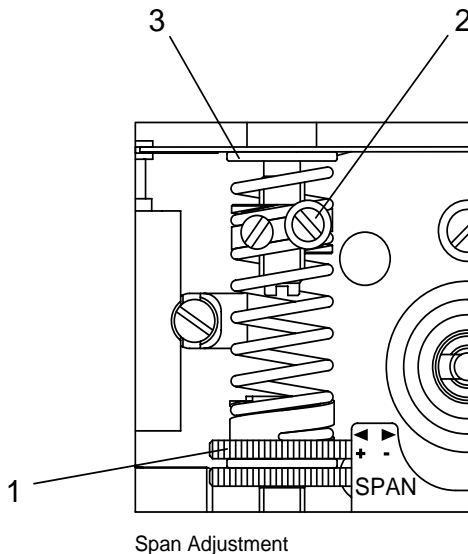
The unit is shipped from the factory pre-calibrated for 90 degree travel (± 0.5 degrees rotation - can also be 30/45/60 degrees, see installed cam). For most applications, the valve closed position is much more critical than the valve open position. Most attention should be made to the valve closed position. Always start calibration procedure by applying 0% input signal, then adjusting zero position. The positioner is calibrated by turning thumbwheels (1) and (4). Arrows on arm (5) indicate turning direction of thumbwheels.

- ◀ "+" = increase zero/span
- ▶ "-" = decrease zero/span

Caution: Cam pinch points may injure fingers. Be sure to avoid placing fingers and other objects in cam pinch points. Also avoid touching balance beam and spool while making adjustments as unpredictable cam rotation may result. Finally, maintain control of input signal while making adjustments.

Calibration Procedure:

1. Apply 0% input signal (0% = 20 kPa, 3 psi, or 4 mA).
2. Wait for steady state. It is important to wait for steady state. On very large actuators, it can take minutes to establish.
3. Adjust zero by turning the silver (lower) thumbwheel (4) with finger or with screwdriver (7) from the outside.
4. Apply 100% input signal (100% = 100 kPa, 15 psi, or 20 mA).
5. Wait for steady state; remember result.
6. Apply 0% input signal.
7. Adjust span per result in step (5) above. This is accomplished by first loosening screw (2), then turning the yellow (upper) thumbwheel (1) in appropriate direction with finger. Tighten screw 2. Spring top must not be in contact with spring guide (3).
8. Check and adjust zero.
9. Repeat steps 2 through 8 until desired calibration is achieved.



Flowserve Corporation
Flow Control Division
www.flowserve.com

1350 N. Mountain Springs Parkway
Springville, Utah 84663-3004
Phone: 801 489 2233

1978 Foreman Dr.
Cookeville, TN 38501
Phone: 931 432 4021

Cam Installation:

Introduction: The standard cam (labeled "K1") features linear, 90 degree operation for full 3-15 psi input, 3-9 and 9-15 psi split ranges, and 3-15 psi 180 degree operation. The factory setting is 3-15 psi, 90 degrees, with "D" (direct) side up for full clockwise position at 3 psi for 90° operation.

Caution: Be sure supply air pressure is removed and no pressure exists in actuator before adjusting cam.

Cam Adjustment:

1. Remove cover and indicator.
2. Loosen the camlock screw (1) and turn the cam locking nut (2) counterclockwise until the cam is loose. It may be necessary to brace the output shaft while loosening the cam locking nut.
3. Adjust the cam (3) as desired, making sure that the cam follower (4) always rides on an active lobe on the cam.
4. Secure the cam by finger tightening the cam locking nut (2), and then tighten the camlock screw (1) (see below).

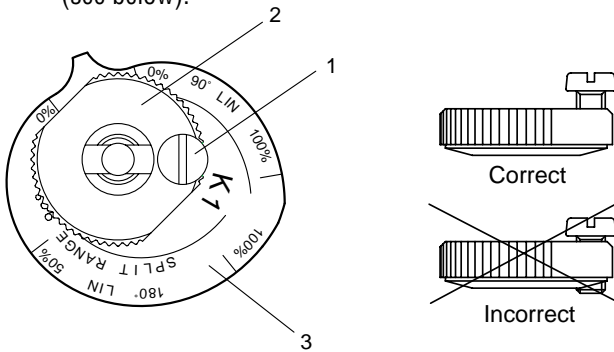
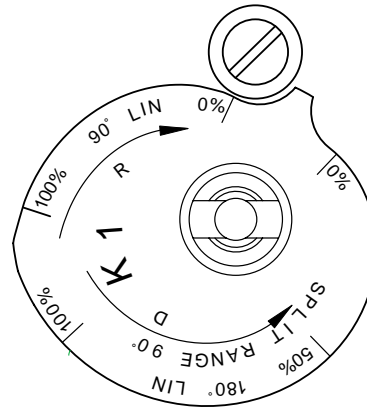
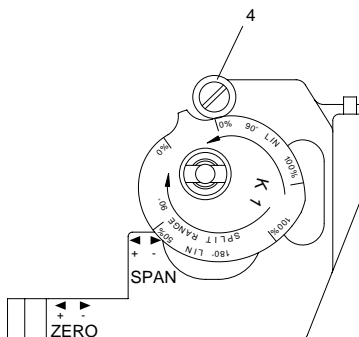


Figure below shows cam setting for reverse action, decreasing signal 100-0% (100-20 kPa, 15-3 psi) to open. Flip cam over, cam follower to ride on lobe R, 0-100%.



Split Range lobe is used to achieve high resolution in split range applications, where only a portion of the signal is used to obtain 90 degrees valve travel. For example, to operate 0 to 90 degrees rotation with 0-50% input signal (20-60 kPa, 3-9 psi), adjust cam follower to ride on Split Range 0-50% lobe D. **Note:** To obtain reverse action, flip cam over and use lobe R.

Figure below shows cam setting for Direct Action increasing signal 0-100% (20-100 kPa, 3-15 psi) to open. Cam follower to ride on lobe D, 0-100%.



Spool Valve Installation:

To change out or inspect spool valve, air supply to the positioner must be removed.

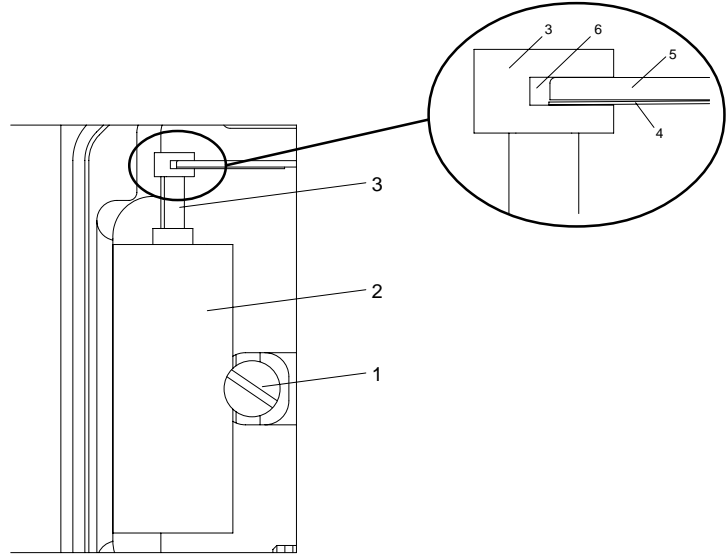
To remove spool valve:

1. Remove screw (1).
2. Carefully lift out entire spool valve assembly (2), disengaging spool (3) from balance arm (5).

To maintain highest performance, do not mix spool and block. Do not lubricate spool valve.

To install new spool valve:

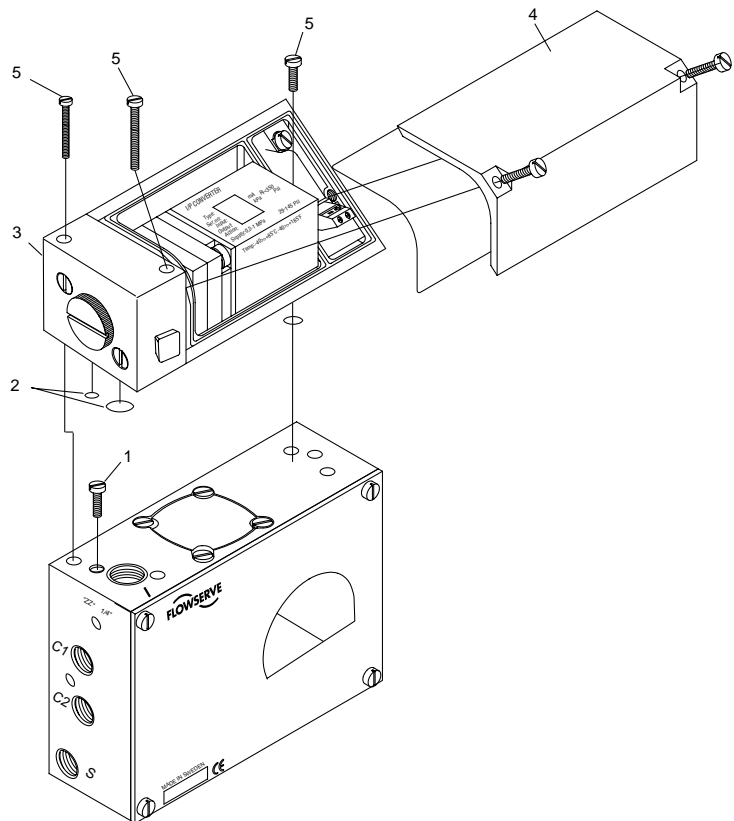
1. Check that O-rings are in place.
2. Insert spool valve assembly (2), making sure that the leaf spring (4) and balance arm (5) engage the slot in the spool (6).
3. Tighten screw (1).
4. Check for smooth operation of assembly.



I-P Installation:

All I-P modules are factory calibrated and cannot be adjusted. Kits are available to allow easy field installation of various input options. Kits include modules, mounting hardware, fasteners, and O-rings.

1. Disconnect signal and supply air from positioner.
2. Remove screw (1) from positioner housing.
3. Make sure O-rings (2) are seated correctly in I-P housing.
4. For weatherproof or intrinsically-safe I-P module, remove cover (4) to allow access to third mounting screw (5).
5. Attach I-P module (3) to positioner housing with three mounting screws (5) provided.



Electrical Specifications:

Model	Agency Approvals	Hazardous Location Rating ¹	Max. Voltage (VDC)	Min. Voltage (VDC)	Max. Current (mA)
4000	None	None	NA	NA	NA
4100	None	None	30 VDC	6 VDC	150 mA
4200	FM	(EX) Cl. 1, Div. 1, Gr. B-D	30 VDC	6 VDC	150 mA
	CSA	(EX) Cl. 1, Div. 1, Gr. B-D	30 VDC	6 VDC	150 mA
4300	DMT	(EX) EEx d IIC T4-T6 ³	30 VDC ⁴	6 VDC	50 mA ⁴
4400 ²	FM	(IS) Cl. 1, Div. 1, Gr. A-D	28 VDC ⁴	6 VDC	50 mA ⁴
	CSA	(IS) Cl. 1, Div. 1, Gr. A-D	28 VDC ⁴	6 VDC	50 mA ⁴
	SCS	(IS) Ex I 1 G EEx ia IIC T6 ³	30 VDC ⁴	6 VDC	110 mA ⁴
	TÜV	(IS) Ex II 2 G EEx ia IIC T6 ³	28 VDC ⁴	6 VDC	60 mA ⁴

Warning: These instruments must be installed in accordance with local and national electrical codes, especially for hazardous locations. Consult unit label to determine specific unit certifications.

Notes:

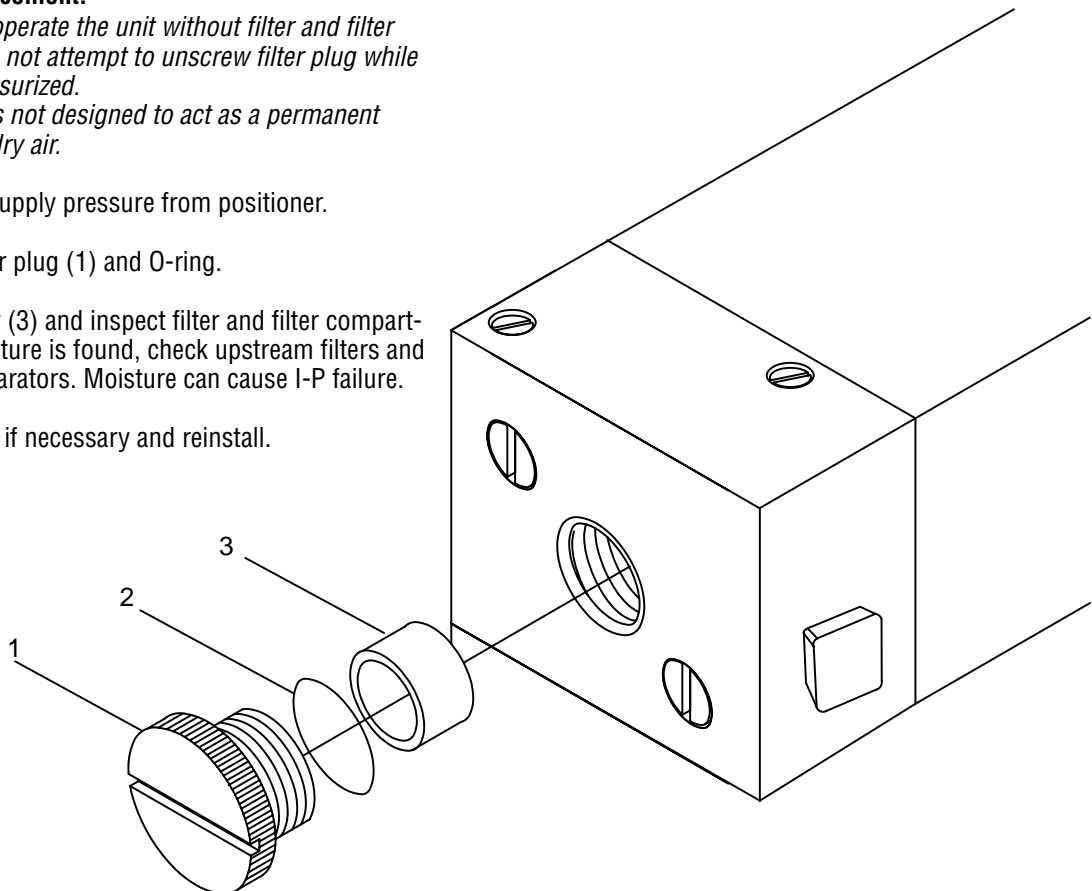
- See hazardous location certificate for detailed temperature ratings. All Apex 4000 units comply with ATEX directive for non-electric equipment intended for use in hazardous locations to EX II 2 G.
- Additional information regarding entity parameters and instructions for wiring to intrinsically-safe I-P may be found in separate IOM, as well as in the hazardous location certificate.
- See hazardous location certificate for special conditions for safe use.
- Maximum voltage and current considerations may be affected by application specifics, such as choice of barrier, ambient temperatures, etc. See hazardous location certificate for additional information.

Filter Plug Replacement:

Caution: Do not operate the unit without filter and filter plug installed. Do not attempt to unscrew filter plug while positioner is pressurized.

Note: This filter is not designed to act as a permanent source of clean, dry air.

- Remove air supply pressure from positioner.
- Unscrew filter plug (1) and O-ring.
- Remove filter (3) and inspect filter and filter compartment. If moisture is found, check upstream filters and oil-water separators. Moisture can cause I-P failure.
- Replace filter if necessary and reinstall.



Maintenance:

The Apex 4000 positioner is designed for long life and trouble-free operation. The following steps should be followed every six months to assure proper operation.

1. Check air supply and associated filtration equipment. See "Supply Air Requirements."
2. Make sure arms, bearings, and adjustment screws move freely. **Caution:** *Moving parts to check freedom with supply pressure connected will cause rotation of cam. Be sure to keep fingers away from cam pinch points.* If parts do not move freely, disassemble and lubricate with a light, instrument grade grease (Lubriplate MAG 1 or equivalent).
3. Check for smooth operation of the spool valve. If it sticks or feels "gummy", remove it and clean both spool and valve bore with solvent. Make sure both parts are clean and dry before reinstalling. Do **NOT** apply grease to these parts.
4. Check for air leaks in air supply.
5. Refer to "Troubleshooting" sections if maintenance does not cure a problem.

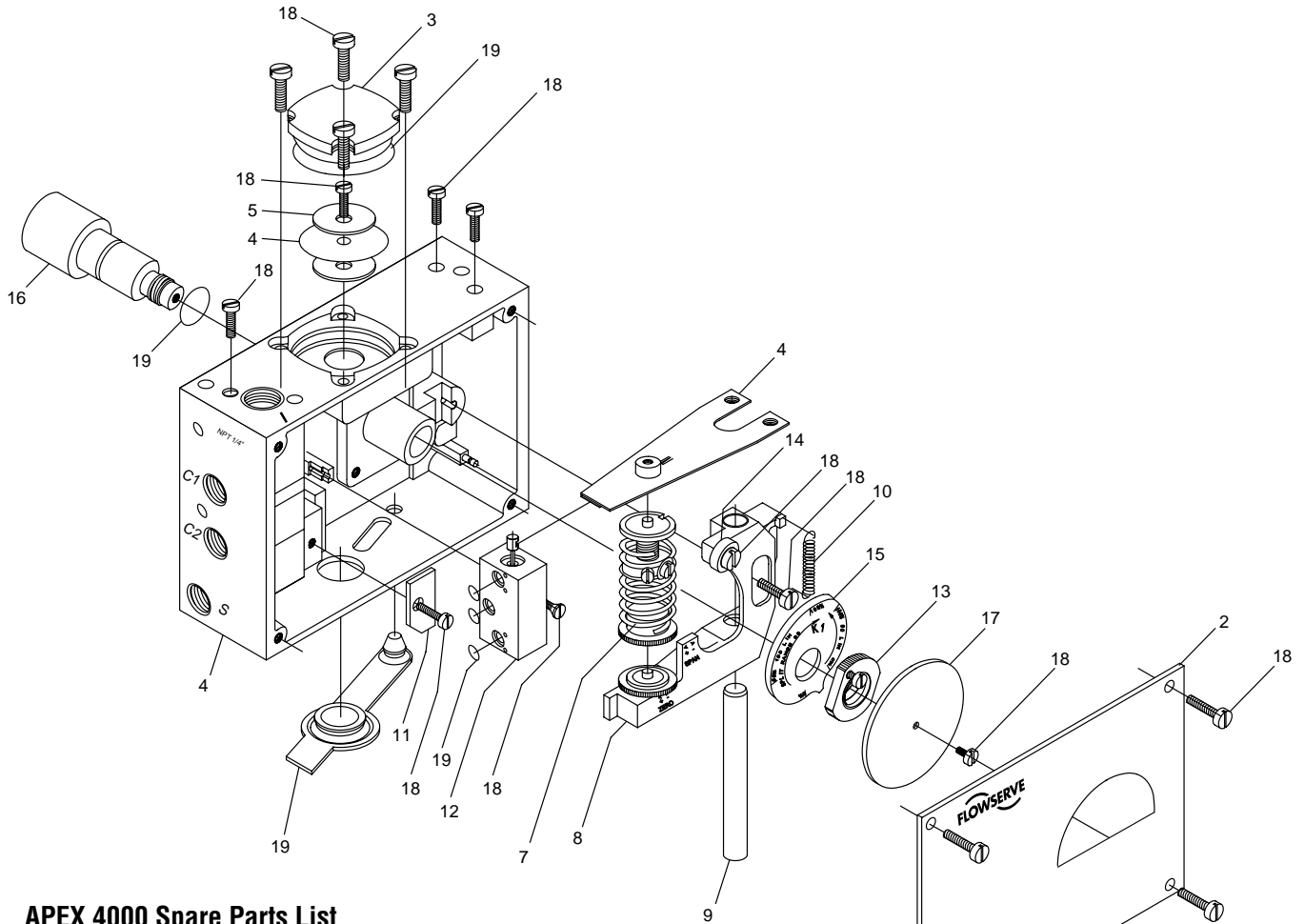
Troubleshooting:

Problem	Probable Cause/Solution
Actuator/Valve won't stroke or goes full stroke with no control:	<ol style="list-style-type: none"> 1. Positioner ports are connected to wrong sides of actuator. 2. Cam on wrong side (see "Cam Installation"). 3. Stuck arm or spool valve (see "Maintenance"). 4. Input signal problem.
Calibration Shifts:	<ol style="list-style-type: none"> 1. Loose mounting hardware. 2. Loose cam locking nut. 3. Loose cam locking screw.
Excessive air consumption (other than normal exhaust of 10-30 scfh):	<ol style="list-style-type: none"> 1. Spool valve seals leaking or loose screws. 2. Air leak between positioner/actuator or within actuator. 3. If condition occurs at end of stroke only, calibration is incorrect.
Oscillation or hunting:	<ol style="list-style-type: none"> 1. Air leak between positioner/actuator or within actuator. 2. Oversized spool valve (decrease size).
Sluggish or slow response:	<ol style="list-style-type: none"> 1. Undersized spool valve (increase size or add volume boosters). 2. Tubing restriction (check supply between positioner/actuator). 3. Tubing too small (increase tubing size).

Flowserve Corporation
Flow Control Division
www.flowserve.com

1350 N. Mountain Springs Parkway
Springville, Utah 84663-3004
Phone: 801 489 2233

1978 Foreman Dr.
Cookeville, TN 38501
Phone: 931 432 4021



APEX 4000 Spare Parts List

Item No.	Spare Part #	Description	Qty
1		Housing	1
2		Front cover	1
3		Diaphragm cover incl. O-ring	1
4		Diaphragm	1
5		Diaphragm washer	2
6		Balance arm	1
7		Feedback spring assembly	1
8		Lower arm assembly	1
9		Rod	1
10		Tension spring	1
11		Lower arm guide	1
12	XK0213+	Spool valve incl. O-rings	1
13		Cam locking nut incl. screw	1
14		Cam follower	1
15	X01162**	Cam 90°/180° Linear 0-100%, split range 0-50-100%	1
16		Output shaft	1
17		Indicator	1
18	XK0216*	Screw set	Set
19	XK0217*	Seal and O-ring set NBR, Nitrile rubber	Set

*Spool Valve Kits

- XK0213 Low flow spool valve assembly (includes O-rings)
- XK0218 High flow spool valve assembly (includes O-rings)

**Cam Options

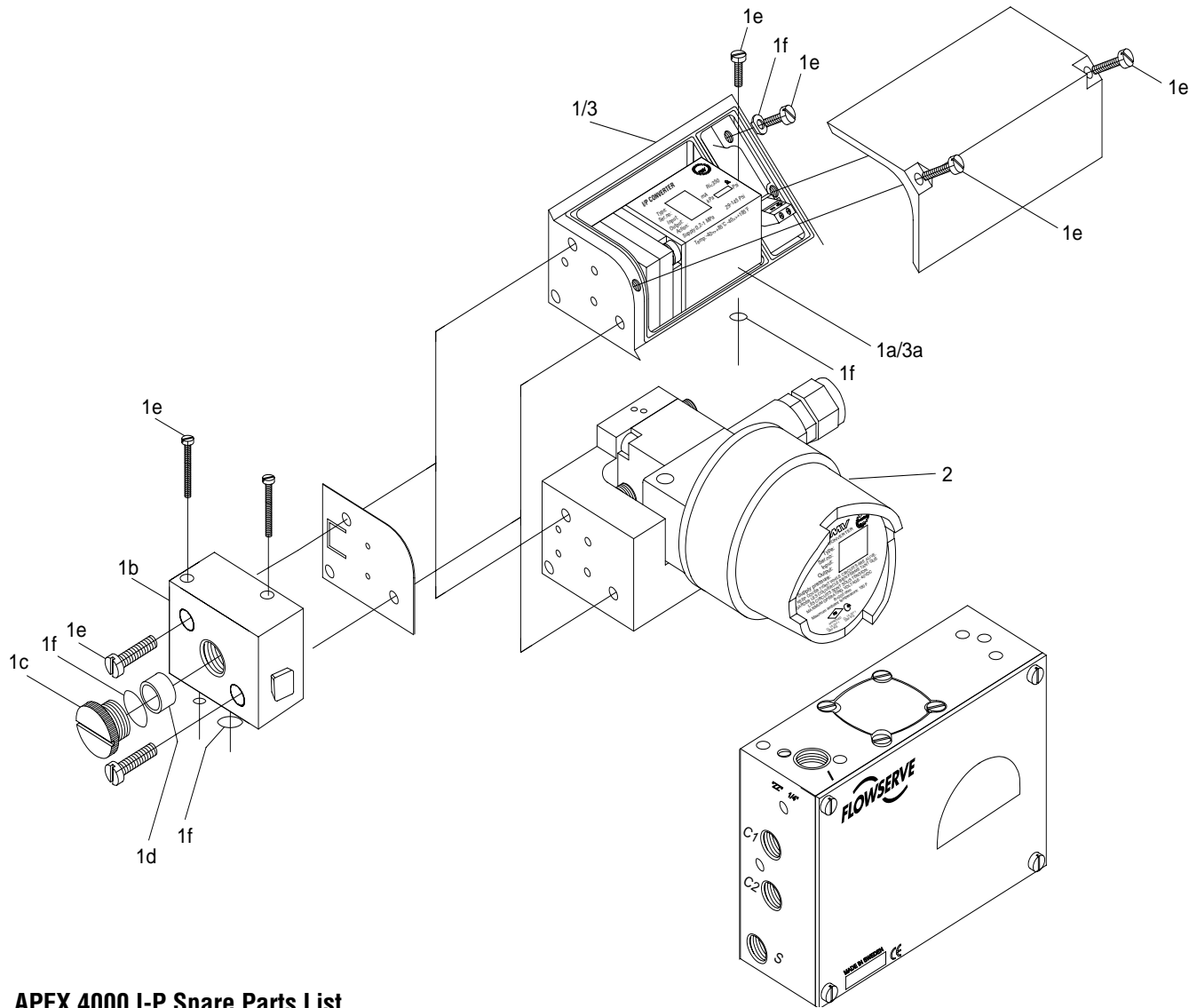
- X01162 Standard linear 90°/180°/split range cam
- X01163 Linear 30°/45°/60° cam
- X01166 Characterized cam, square, equal percentage
- X01167 Linear 60°/120° butterfly valve cam

*Screw set and seal kit include components for I-P units also.

Flowserve Corporation
Flow Control Division
www.flowserve.com

1350 N. Mountain Springs Parkway
Springville, Utah 84663-3004
Phone: 801 489 2233

1978 Foreman Dr.
Cookeville, TN 38501
Phone: 931 432 4021



APEX 4000 I-P Spare Parts List

Item No.	Spare Part #	Description	Qty
1	KM41	General purpose I-P kit	Kit
1a		General purpose I-P module	1
1b		I-P base block assembly (common)	1
1c		I-P filter plug (common)	1
1d	XK0219	I-P filter (common)	1
1e	XK0216*	Screw set (includes base 4000 components)	Set
1f	XK0217*	Seal and O-ring set (includes base 4000 components)	Set
2	KM42	Explosion-proof I-P kit	Kit
2a		Explosion-proof I-P module	1
3	KM44	Intrinsically-safe I-P kit	Kit
3a		Intrinsically-safe I-P module	1

* Note: KM kits do not include complete screw set and seal kit.
Complete screw sets and seal kits must be ordered separately.