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CHAPTER 1: PRODUCT DESCRIPTION

AVCS offers a broad range of pneumatic rack & pinion actuators. **AVCS** actuators are designed to operate with dry or lubricated air media, but will function equally well with non-corrosive and inert gas or light hydraulic oil. The actuators are offered in two different configurations: double acting and spring return. Each actuator can be easily converted from double acting to spring return (or vice versa) by insertion (or removal) of spring cartridges.

AVCS actuators are equipped in the standard configuration with the following unique features:

- Double travel stops (Note: AV04, AV71, and AV76 have open travel stops only)
- External open/closed indication
- Pre-compressed springs
- Carbon steel electroless nickel coated pinion
- Shaft bearings which isolate the pinion gear from the housing and support the shaft for high cycle applications
- All bodies internally honed to reduce wear
- All internal and external surfaces anodized for corrosion resistance
- End caps and pistons epoxy powder coated for corrosion resistance
- Angle of rotation: 90° - 120° - 135° - 150° - 180° (240° on request)
- All air line connections are 1/4" NPT
- "NAMUR" VDI/VDE 3845 and ISO 5211 dimensions on all sizes

CHAPTER 2: TECHNICAL FEATURES & DATA

2 – 1 METHOD OF OPERATION

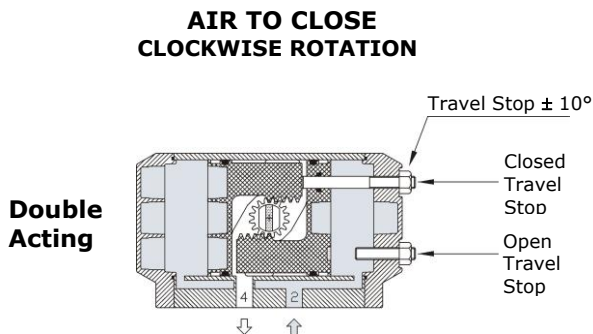


Figure 2.a

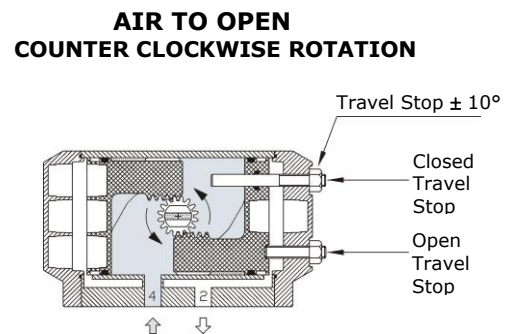


Figure 2.b

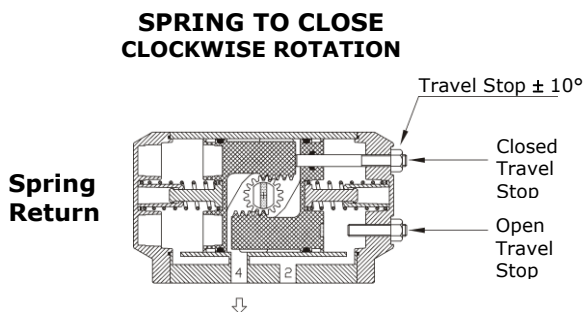


Figure 2.c

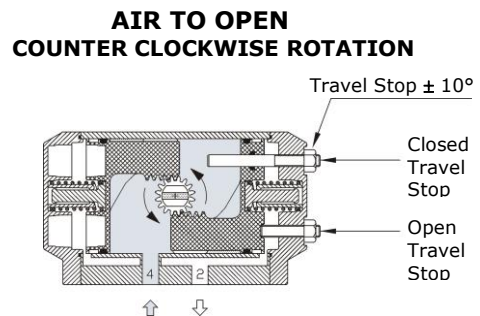


Figure 2.d

DOUBLE ACTING

Note: The numbers in parentheses refer to the actuator exploded view on page 8.

Rotation occurs when compressed air is supplied to the actuator through Port 4, connected to the interior cavity between the pistons (ref. 7 & 15), or through Port 2, connected to the end cap area (ref. 2 & 20).

- As shown in **Figure 2.a**, pressure to Port 2 fills the outer cavities pushing both pistons (ref. 7 & 15) inward and exhausting air through Port 4. As the pistons retract, they rotate the pinion (ref. 24) clockwise (when viewed from the top of the actuator).
- Pressure to Port 4, as shown in **Figure 2.b**, fills the inner cavity pushing both pistons (ref. 7 & 15) outward and exhausting air through Port 2. As the pistons extend they rotate the pinion (ref. 24) counter clockwise (when viewed from the top of the actuator)

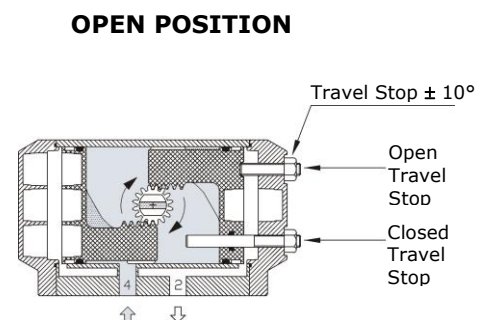
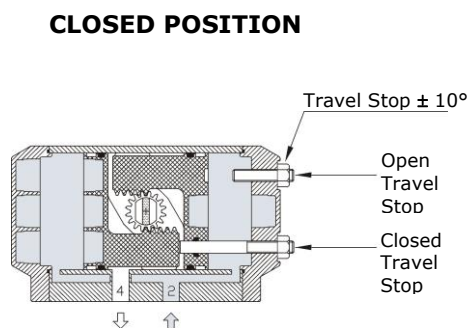
SPRING RETURN

Note: The bracketed numbers refer to the actuator exploded view – page 8.

In this configuration, the closed position occurs with spring cartridges (ref. 4), which are located between the pistons and end caps.

- Relieving pressure from the inboard cavity through Port 4, as shown in **Figure 2.c**, allows the spring cartridges (ref. 4) to push both pistons (ref. 7 & 15) inward. As the pistons retract, they rotate the pinion (ref. 22) clockwise (when viewed from the top of the actuator).
- Pressure to Port 4, see **Figure 2.d**, fills the inboard cavity pushing both pistons outward and exhausting air through Port 2. As the pistons (ref. 7 & 15) extend they rotate the pinion (ref. 22) counter clockwise (when viewed from the top of the actuator) and compress all the spring cartridges (ref. 4).

Although **AVCS** actuators typically operate counter clockwise to open and clockwise to close, it is possible to change this style of operation. **Figure 2.e** and **2.f** show the same double acting actuator with the piston orientation changed to convert the actuator from a fail clockwise configuration to a fail counter clockwise configuration (as described in Chapter 4 – 5).



2 – 2 TECHNICAL DATA & WORKING CONDITIONS

- Operating Media – Dry or lubricated air, non-corrosive and inert gas, or light hydraulic oil.
- Air supply: 40 PSIG (3 Bar) to 150 PSIG (10 Bar) maximum. *A safety valve is normally recommended.*
- Temperature: Standard from –10°F to +176°F. Higher temperature (+250°F continuous and +300°F cyclic) and lower temperature (-55°F) available on request.
- Lubrication: Factory lubricated for life under normal working conditions with **Exxon CAZAR K2** or equivalent
- Application: Suitable for both indoor and outdoor applications.

2 – 3 SPECIAL CONDITIONS

- When the actuator is to be operated with oxygen, the actuator must be perfectly clean and specially lubricated.
- Operating the actuator beyond its designed temperature limitations may damage internal and external components and, therefore, could prove potentially dangerous for operating and maintenance personnel.
- Operating the actuator beyond its designated pressure limitations may result in either an actuator malfunction or an actuator explosion and, therefore, could prove potentially dangerous for operating and maintenance personnel.
- **Note:** Do not disassemble the actuator end caps when air pressure is applied to the actuator.

CHAPTER 3: INSTALLATION

AVCS actuators can be fitted on many styles of quarter-turn valves, including ball, butterfly, and plug and dampers in accordance with the instructions contained in this chapter.

AVCS actuators are designed to be easy to install; for this purpose a mounting hole pattern (ref. 27 of the actuator exploded view page 8 and **Figure 3.a**) has been designed. The hole pattern is an integral part of the body and is equipped with ISO 5211 drilling (**Table a**) in order to allow a male/female or female/male coupling with the valve.



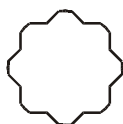
Figure 3.a
Bottom view of
AVCS AV actuator

DRILLING HOLE PATTERN		
TYPE	STANDARD	OPTIONAL
AV04	F03 (Ø1.417)	-
AV12	F04 (Ø1.654)	F03 (Ø1.417) + F05 (Ø1.969)
AV16	F05 (Ø1.969) + F07 (Ø2.756)	F04 (Ø1.654) + F07 (Ø2.756)
AV17	F05 (Ø1.969) + F07 (Ø2.756)	-
AV21	F05 (Ø1.969) + F07 (Ø2.756)	-
AV26	F05 (Ø1.969) + F07 (Ø2.756)	-
AV31	F07 (Ø2.756) + F10 (Ø4.016)	-
AV36	F07 (Ø2.756) + F10 (Ø4.016)	-
AV41	F07 (Ø2.756) + F10 (Ø4.016)	-
AV46	F07 (Ø2.756) + F10 (Ø4.016)	-
AV51	F10 (Ø4.016) + F12 (Ø4.921)	-
AV56	F10 (Ø4.016) + F12 (Ø4.921)	-
AV61	F10 (Ø4.016) + F14 (Ø5.512)	-
AV66	F10 (Ø4.016) + F14 (Ø5.512)	-

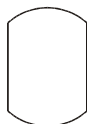
Table a

Note: The numbers in parentheses indicate the diameter of the hole circle pattern in inches.

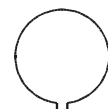
The pinion presents a double – square female drive to allow a large flexibility in mounting; it allows the assembling on valves stem, or coupling, with square key at 45° or at 90°. On request, the bottom pinion female key may be done as double D or cylindrical with one or two keyways.



Double Square key



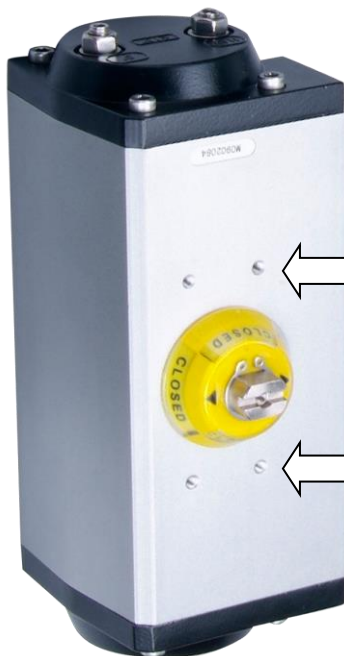
Double D key



Keyways key

On the top face of **AVCS** actuators, there is a NAMUR standard mounting pattern for easy installation of accessories for position indicating and/or control devices (Limit Switch Boxes, Positioners, etc).

Figure 3.b shows an actuator in the normal position (closed) with the pinion flats and the indicator – drive milling perpendicular to the body



NAMUR drilling:
Limit Switch and Positioner
mounting area.

Figure 3.b
Top view of **AVCS** AV actuator

The Ports are NAMUR standard for easy solenoid valve connection

Installation procedure:

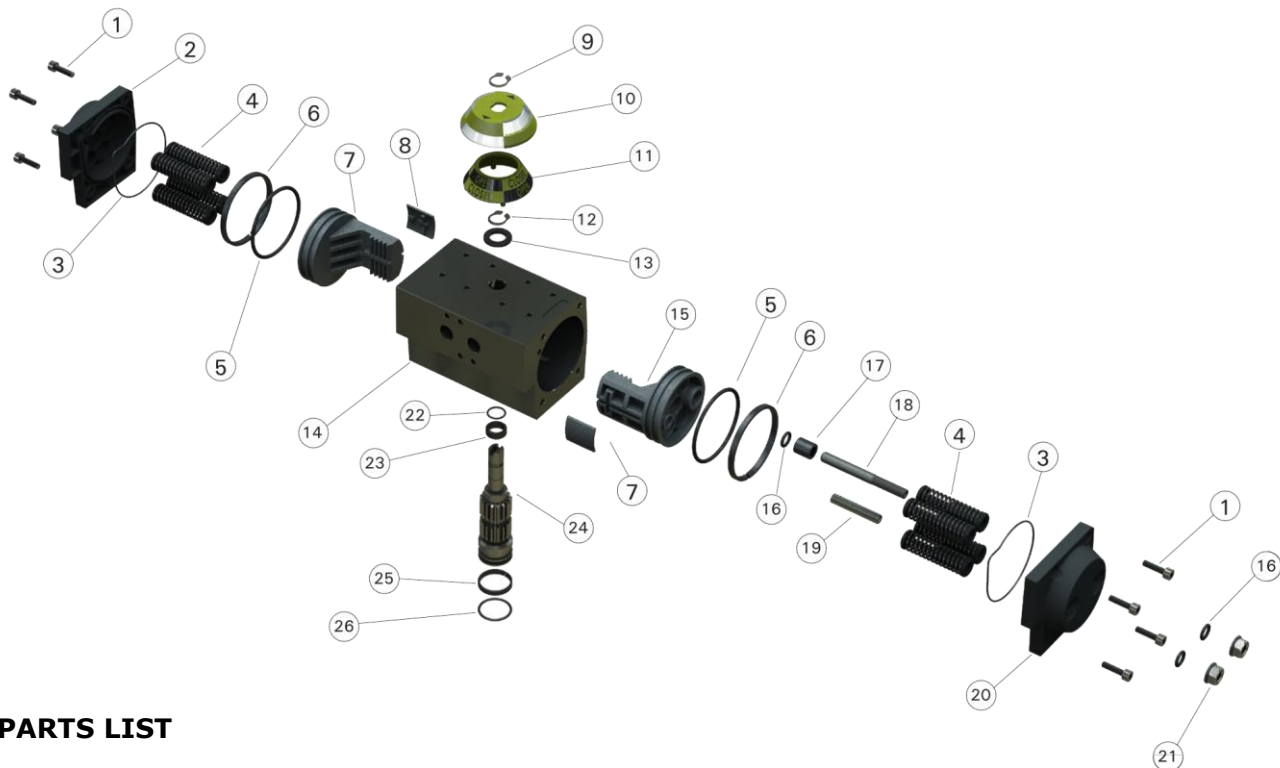
1. Check the coupling female pinion drive – valve stem.
2. Make sure that the valve and the actuator are both in the **closed** position before proceeding (see **Figure 3.b**).
3. Install the mounting bracket on the valve and hand-tighten all fasteners; be sure not to fully torque the bolts until the entire assembly is correctly aligned and installed.
4. a) **Mounting with brackets:** Place the coupling on the valve stem and the actuator on the mounting bracket. Align the valve and actuator in order to eliminate forces on the system; tighten all the assembly fasteners.

-
- b) **Direct mounting:** Position the actuator on the valve; use caution while inserting the valve stem into the double square female pinion drive. Insert the bolts from the bottom side of hole pattern and manually tighten them and align the assembly in order to eliminate any eccentric forces on the system; tighten all assembly fasteners.
5. Actuate the unit several times to ensure that it works properly. If the unit does not work properly, disassemble the unit and repeat steps 1 – 4. If the problem persists, contact your local **AVCS** representative.
6. After the completion of the mounting operations, it is necessary to set the actuator stroke through the travel stops to ensure that the valve works properly. **AVCS** actuators have a regulation range from -10° to +10° and from 80° to 100° ($\pm 10^\circ$ adjustability in both the open and closed positions). (See Chapter 4 – 3 for information on positioning the actuator).
7. Rotate the actuator and valve assembly to the desired degree.

CHAPTER 4: MAINTENANCE

Maintenance instructions provide the end user with necessary information for standard examination of O-rings and soft parts for wear. Repair kits containing all soft parts which may need replacing are readily available.

EXPLODED VIEW



PARTS LIST

Item	Description	Materials	Item	Description	Materials
1	End Cap Bolts	AISI 304 Stainless Steel	14	Actuator Body	Extruded Aluminum (6063 or 6005)
2	Left End Cap	Die Cast Aluminum Epoxy Coated	15	Right Piston	Die Cast Aluminum Epoxy Coated
3	End Cap O-Ring	BUNA-N	16	Travel Stop O-Ring	BUNA-N
4	Spring Cartridge	Spring Steel Epoxy Coated	17	O-Ring Retainer	Technopolymer
5	Piston O-Ring	BUNA-N	18	Closed Travel Stop	AISI 304 Stainless Steel
6	Piston Wear Bearing	Technopolymer	19	Open Travel Stop	AISI 304 Stainless Steel
7	Left Piston	Die Cast Aluminum Epoxy Coated	20	Right End Cap	Die Cast Aluminum Epoxy Coated
8	Piston Skate	Technopolymer	21	Travel Stop Nuts	AISI 304 Stainless Steel
9	Indicator Snap Ring	AISI 304 Stainless Steel	22	Upper Pinion O-Ring	BUNA-N
10	Indicator Window	Technopolymer	23	Upper Pinion Bearing	Technopolymer
11	Indicator	Technopolymer	24	Pinion	Nickel Plated Carbon Steel
12	Pinion Snap Ring	AISI 304 Stainless Steel	25	Lower Pinion Bearing	Technopolymer
13	Upper Pinion Washer	Technopolymer	26	Lower Pinion O-Ring	BUNA-N

4 - 1 DISASSEMBLY PROCEDURE FOR THE SUBSTITUTION OF O-RINGS, PISTON WEAR BEARINGS, AND PISTON SKATES

CAUTION – PLEASE READ CAREFULLY:

- BEFORE CARRYING OUT ANY MAINTENANCE ON *MAX-AIR* TECHNOLOGY ACTUATORS, IT IS ESSENTIAL THAT THE ACTUATOR IS NOT UNDER PRESSURE AND IS FREE OF ANY ACCESSORIES.
- FOR YOUR SAFETY, IT IS ABSOLUTELY NECESSARY, BEFORE DISASSEMBLING A SPRING-RETURN ACTUATOR, THAT THE UNIT IS IN THE FAILSAFE POSITION (SPRINGS EXTENDED AND NOT COMPRESSED).

1. Disconnect all electrical and air supplies from the actuator.
2. Remove the actuator from the mounting bracket and place it in a clean environment.
3. After removing the end cap screws (ref. 1), remove the end caps (ref. 2 & 20).
4. Remove the O-Rings (ref. 3) from the end caps and inspect their wear and lubrication.
5. Remove the travel stops (ref. 18 & 19) from the right end cap.
6. Using a wrench on the flats on the upper part of pinion (ref. 24), turn the pinion counter-clockwise until the pistons (ref. 7 & 15) stick out from the sides of the actuator.
Note: If actuator is fail counter-clockwise (**mounting B**), the pinion must be rotated in the opposite direction.
7. Remove the pistons by hand or with pliers, grabbing the pistons by the spring grooves while using caution not to damage the pistons' surfaces.
8. Remove O-Rings (ref. 5), guide ring (ref. 6) and thrust block (ref. 8) from the left and right pistons.
9. Remove the indicator snap ring (ref. 9) and the indicator beacon (ref. 10 & 11). A screwdriver may be used to gently pry off the indicator window (ref. 10).
10. Remove the pinion snap ring and the upper pinion washer (ref. 12 & 13) and then gently tap out the pinion (ref. 24) with a rubber mallet or similar tool.
11. Remove the O-Rings and the bearings (ref. 22, 23, 25 & 26) from the pinion.

Inspect and replace the following wear parts as necessary:

<i>General</i>	<i>Reference</i>	<i>Detail</i>	<i>Qty.</i>
End cap (ref. 2 & 20)	3	End cap O-Rings	2
Piston (ref. 7 & 15)	5	Piston O-Ring	2
	6	Piston wear bearing	2
	8	Piston skate	2
Travel stop (ref. 18 & 19)	13	Travel stop O-Ring	3
	17		
Pinion (ref. 24)	20	Pinion O-Ring (upper)	1
	21	Pinion bearing (upper)	1
	23	Pinion O-Ring (lower)	1
	24	Pinion bearing (lower)	1

All these soft parts are included in **AVCS** repair kits.

4 – 2 LOW/ HIGH TEMPERATURE O-RINGS INSTALLATION

- Disassemble the actuator as described in chapter 4 – 1.
- Using a screw driver, remove the following O-Rings from the actuator:
 - Pistons (ref. 5).
 - End caps (ref. 3).
 - Upper pinion (ref. 22).
 - Lower pinion (ref. 26).
- Using alcohol, or another mild solvent, remove the lubrication from each actuator part and carefully clean all the surfaces before inserting a new set of O-Rings.
- Divide the O-Rings and indicate their position of installation:
 - Piston O-Rings: they are the thickest O-Rings (ref. 5)
 - End cap O-Rings: they have the biggest diameter (ref. 3)
 - Pinion O-Rings: of the remaining O-Rings, the large diameter O-Rings goes on the Lower O-Ring groove (ref. 26) and the smaller diameter on the Upper O-Ring groove (ref. 22)
 - Travel Stop O-Rings (ref. 16)
- Install the low/high temperature O-Ring set. If this operation is too difficult, the O-Rings can be slightly stretched and greased to ease installation. When installing the end cap O-Ring, be sure to seat them properly, otherwise they might be pinched during the end cap installation (ref. 2 & 3).
- Apply grease* to the following internal part of actuator:
 - Inner bore of actuator
 - Piston wear surfaces (O-Ring, wear bearing, and skate)
 - Piston rack
 - Pinion gear teeth
 - Pinion wear surfaces and O-Rings
- Assemble the actuator as described in chapter 4 – 3.

*Low Temperature Grease:
 Use PST-407 from Polysi
 Technologies or equivalent
 polypropylene-glycol-based
 lubricant.

4 – 3 ASSEMBLY PROCEDURE

1. Insert O-Rings (ref. 22 & 26) and bearings (ref. 23 & 25) on pinion (ref. 24).
2. Insert the pinion into the actuator body (ref. 14), pushing gently until the pinion is completely inserted into the body.
3. **Intermediate test:** Using a wrench and acting on the appropriate mill on the upper part of the pinion, manually rotate the pinion to make sure it freely rotates.
4. Insert the O-Rings (ref. 5), the wear bearings (ref. 6) and the skates (ref. 8) on the left and right pistons (ref. 7 & 15).
5. **Piston insertion:** This operation can be performed in two different ways in order to obtain either a fail clockwise actuator (**mounting A - FCW**) or a fail counter clockwise actuator (**mounting B - FCCW**). The right piston (travel stop piston) is the piston which has a hole, as opposed to the left piston which has no hole. While facing the supply ports on the actuator body, insert the left piston into the left side of body and the right piston into the right side.

8a. Mounting A:

Left piston insertion:

- Place the actuator in an upright position on its right side with the bottom facing you and the supply holes on your right.
- To obtain the counter clockwise rotation (mounting A) it is necessary to insert the rack of the piston to the left of the pinion as in the exploded view on page 8.
- Insert the left piston, applying pressure with hands until the piston is completely in the body.

Right piston insertion:

- Place the actuator in an upright position on its left side with the bottom facing you.
- Insert the rack of the piston to the left of the pinion.
- Insert the right piston applying pressure with hands until the piston is completely in the body.

8b. Mounting B:

Follow the same steps as above, but position the rack of both pistons to the right of the pinion.

9. Actuator positioning phase:

- 9a.** Place the actuator in an upright position on a flat surface with the upper part of the pinion on the right side.
- 9b.** Manually apply pressure to the piston, as this will assist in compressing the opposite piston.
- 9c.** While continuing to apply pressure, use a wrench on the appropriate mill of the upper portion of the pinion and rotate the pinion counter clockwise (clockwise for FCCW). At this point there must be clicking sound due to the interlocking between the piston rack and the pinion tooth. Make sure to create an individual sound per tooth.
- 9d.** After each individual sound, rotate the pinion clockwise (counter clockwise for FCCW); verify that the pinion Namur slot is about 10° past perpendicular to the body axis. If this isn't working, repeat step 9c.
- 9e.** Double-check the correct assembly of the actuator, confirming that the open position pistons are of equal distance from the cylinder border.

10. End cap mounting:

- 10a.** Insert the end cap O-Rings (ref. 3) into their grooves by following the shape of the grooves with a finger to ensure that the O-Rings are properly seated.
- 10b.** Insert the travel stops (ref. 18 & 19) into the right end cap (ref. 20) from the external side of the end cap. Screw clockwise until they appear inside the end cap.
- 10c.** Insert the O-Rings (ref. 16), the washer (ref. 17) and the nuts (ref. 21).
- 10d.** Insert the end cap bolts (ref. 1) and tighten them in an alternating order to the factory torque standard (see Table b).

ACTUATOR TYPE	TORQUE In-Lb (Nm)
AV16	70 (8)
AV21 – AV26	106 (12)
AV31 – AV36 AV41 – AV46	133 (15)
AV51 – AV56 AV61 – AV66	193 (22)

Table b

11. Adjustment:

- Supply low-pressure compressed air to Port 2 (see drawings Chapter 2 – 1). Using a hex key wrench, turn the closed travel stop until the pinion shaft is perpendicular to the actuator axis (0° position); tighten the nut to the correct of the torque listed in **Table b**.
- Next, supply low-pressure compressed air to Port 4 to open the actuator. The pinion slot must be at a 90° position (with respect to the 0° position), aligned with the actuator axis. If it is not aligned, adjust the travel stop and then tighten the nut to the correct torque listed in **Table b**.

4 - 4 SPRING CARTRIDGE INSERTION

AVCS actuators can be easily converted from Double Acting (DA) to Spring Return (SR) by inserting springs on each side between the pistons and the end caps. **AVCS** actuators can accept up to **5 springs in the right end cap** and **7 in the left end cap**. We advise the insertion of at least two spring cartridges in each end cap in order to have a uniform distribution of forces on the pistons. The number of the springs loaded affects the torque that the actuator will be able to generate during its working cycle. See the **AVCS** data sheet to properly size a spring return actuator.

Springs Installation Procedure:

1. Remove the four end cap bolts (ref. 1) from the right and left end caps (ref. 2 & 20);
2. Remove the end caps (ref. 2 & 20);
3. Insert the correct number of spring cartridges into **each** end cap (e.g. MT16-S4 = 4 + 4 springs), referring to **Table c**. It is strongly recommended to insert the plastic part of the cartridge containing the deep hole into the end cap seat rather than the piston seat.

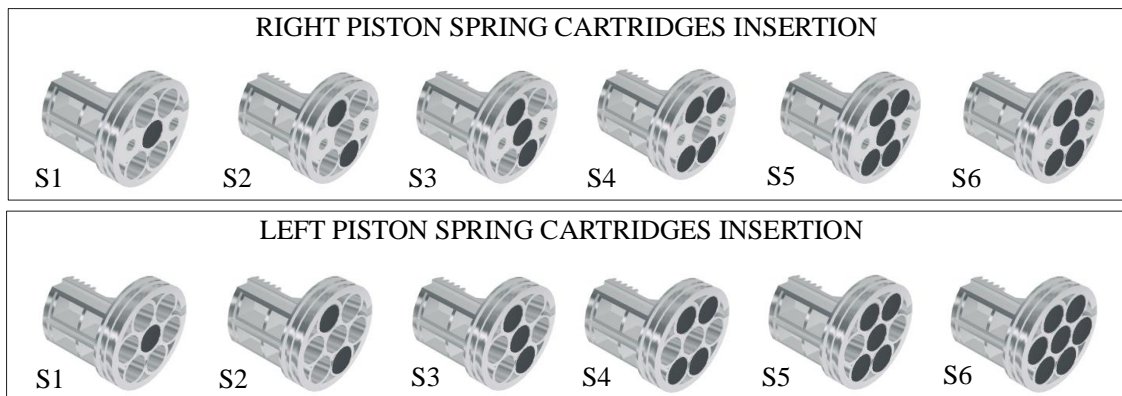


Table c