

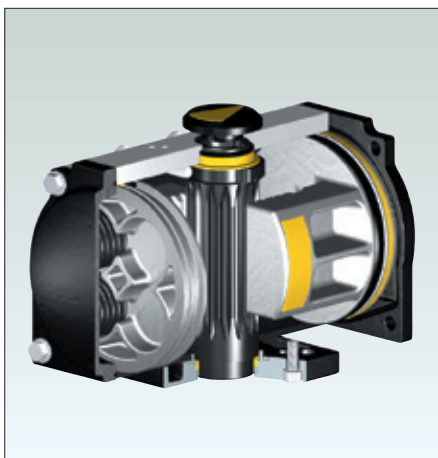


KEYSTONE

Features

- Direct mounting to all Keystone butterfly valves.
- Double rack & pinion design nullifies side loads on the pinion shaft, minimizing bearing wear and extending life.
- Double acting or spring return models utilize the same compact body design.
- Aluminum body, hard anodized externally and internally, for corrosion and wear resistance.
- Electrostatic powder coating (ESPC) finish, external on body, internal and external on end caps, protects against corrosive environments.
- Adjustable travel stops.
- Safe end cover bolting requiring no special tools.
- Anti-blowout drive pinion.
- Over travel adjustment (at each end) +5°.
- Under travel adjustment (at each end) -10°.
- Easy field conversion between DA and SR models.

A comprehensive range of pneumatic actuators, providing compact, reliable and economical powered operation for all types of quarter-turn valves



Mounting specifications

Actuator to valve:

Keystone standard

Accessories:

NAMUR VDI/VDE 3845 or Keystone standard

Technical data

Torque output range:

Double acting 204 - 22902 lbs in

Spring return 69 - 10155 lbs in

Operating medium:

Air (dry or lubricated)

Travel adjustment:

Over travel (at each end) +5°

Under travel (at each end) -10°

Increased under travel is available, on request.

Temperature range: -20°F to 210°F

Air supply pressure: 120 psi maximum

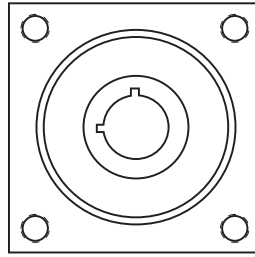
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Operation

Double and single acting actuators

Both the double acting and spring return MRP actuators feature a compact design with the same envelope dimensions. This flexible unit can be converted from double acting to single acting in the field without special charts to decipher color codes on which springs to use. The spring return actuator is available with spring sets from 40 pounds to 100 pounds in 10 pound increments. The springs are manufactured from heavy gauge wire to assure long life and corrosion resistance.

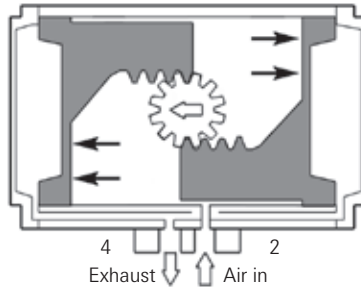
Actuator mounting pad of the Keystone MRP: The dual-keyed input shaft allows parallel or perpendicular mounting to the valve flow.



Standard double acting

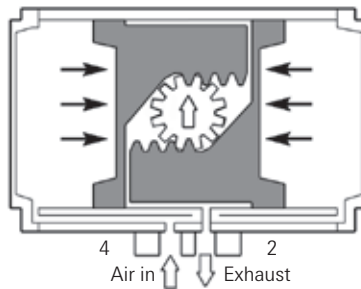
To OPEN valve

In a double acting application, air pressure is introduced to Port 2, pressurizing the space between the pistons and driving the pistons out towards the actuator ends. The volume of air above the piston heads is exhausted to atmosphere. This causes the piston racks to drive the pinion in a counterclockwise direction, resulting in a quarter-turn rotation. This rotation is transferred to the valve shaft, opening the valve.



To CLOSE valve

Air pressure introduced to Port 4, pressurizing the spaces above each piston head and driving the pistons inward. The volume of air between the pistons is exhausted to atmosphere. This causes the piston racks to drive the pinion in a clockwise direction, resulting in a quarter-turn rotation. This rotation is transferred to the valve shaft, closing the valve.

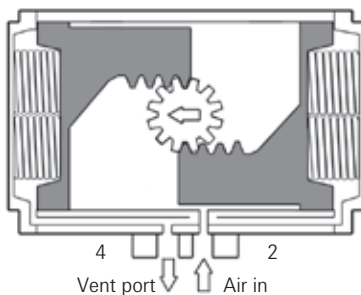


Spring return

To OPEN valve

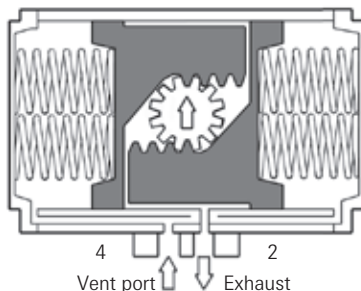
In a single acting application, air pressure is introduced to Port 2, pressurizing the space between the pistons and driving the pistons out towards the actuator ends while at the same time compressing the springs.

This causes the piston racks to drive the pinion in a counterclockwise direction, resulting in a quarter-turn rotation. This rotation is transferred to the valve shaft, opening the valve.



To CLOSE valve

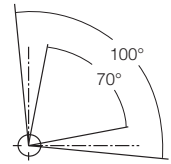
When the air pressure is relieved, the spring compression moves the pistons inward and exhausts the air through Port 2. This causes the piston racks to drive the pinion in a clockwise direction, resulting in a quarter-turn rotation. This rotation is transferred to the valve shaft, closing the valve.



Travel adjustments

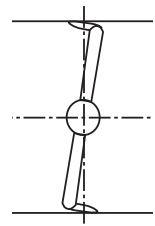
Within the mechanical connections of the drive between the valve and the MRP actuator there are several points of manufacturing tolerance, including valve disc or ball to stem, stem to adapter and adapter to actuator that must be compensated for in the operation of the assembly. Therefore, adjustment is necessary to ensure that valve operation is as precise as required. With the MRP, Dual travel stops allow adjustment at both ends of the stroke. Maximum adjustment range of 70° to 100° rotation, including an over travel of 5° and an under travel of 10°.

The standard travel stops also provide the desired adjustment necessary for proper operation of various valve types, as detailed.



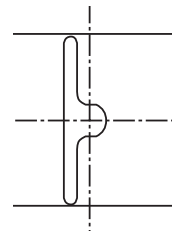
Resilient seated butterfly valves

Shut-off occurs before the disc has rotated a full 90° from the open position. Travel adjustment is therefore desirable to prevent over travel, which would result in unnecessary operating torque and premature deterioration of seat life. In the open position, adjustment is necessary to ensure maximum flow through the valve and minimum dynamic forces acting on the disc.



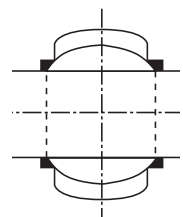
High performance butterfly valves

The double offset design of high performance butterfly valves results in the disc moving into the seat with a camming action. It is important that the disc does not travel beyond the seat position, otherwise damage to the seat will occur.



Ball and plug valves

The ball or plug must be precisely in line with the valve port to prevent damage to the seat in the open position. Adjustment at the closed position is necessary to ensure that complete shut-off is achieved.



MRA rack & pinion actuator



The MRA version of the popular Keystone MRP rack & pinion actuator offers increased resistance to caustic wash down utilized in many food and beverage applications. This version has all of the features enjoyed by users of the MRP – a hard anodized body that enhances outside environmental protection plus provides a hard, corrosion resistant internal surface for the bearings and pistons. This results in a longer life span with less downtime.

The end caps are coated with chromate plus E.S.P.C. inside and out, thus keeping this rack & pinion working long and hard for the customer. The E.S.P.C. treatment for the body and end caps plus SNP* protection for the pinion offers that next step required for harsh indoor environments such as caustic wash down areas.

* Special nickel protection

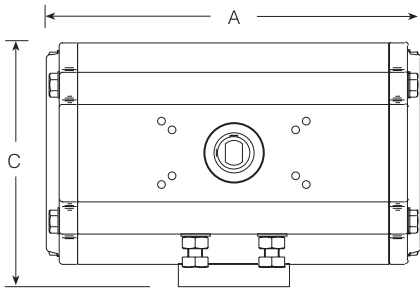
Ordering guide

| Example | MRP - 004 | U | - | K | - | D | 000 | - | — |
|-------------------------------|-----------|---|---|---|---|---|-----|---|---|
| Actuator coating | | | | | | | | | |
| P – Black powder coat | | | | | | | | | |
| A – Grey epoxy coating | | | | | | | | | |
| Actuator size | | | | | | | | | |
| 004 009 | | | | | | | | | |
| 014 025 | | | | | | | | | |
| 037 045 | | | | | | | | | |
| 070 088 | | | | | | | | | |
| 180* 181* | | | | | | | | | |
| Mounting base threads | | | | | | | | | |
| U – UNC | | | | | | | | | |
| Mounting base drilling | | | | | | | | | |
| K – Keystone direct mount | | | | | | | | | |
| Actuator configuration | | | | | | | | | |
| D – Double acting | | | | | | | | | |
| S – Spring return | | | | | | | | | |
| Spring range | | | | | | | | | |
| 000 – None | | | | | | | | | |
| 040 – 40 psi | | | | | | | | | |
| 060 – 60 psi | | | | | | | | | |
| 080 – 80 psi | | | | | | | | | |
| 100 – 100 psi | | | | | | | | | |
| Seal options | | | | | | | | | |
| Blank – Std Nitrile | | | | | | | | | |
| VT – Viton® | | | | | | | | | |
| LT – Low Temp | | | | | | | | | |

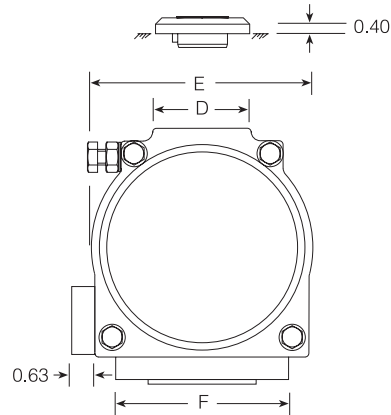
* Models 180 and 181 only available as MRP

Dimensions (inches)

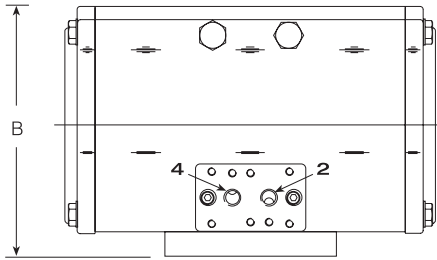
Top view



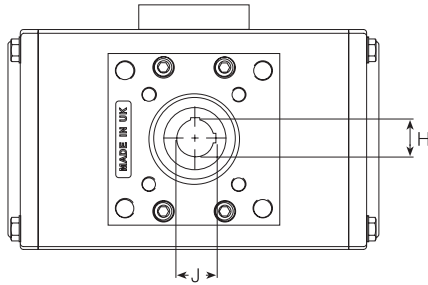
Front view



Side view



Bottom view



Note:

For size 180/181 only, spring return model has an extended body, due to the addition of spring packs. Dimension 'A' is then 27.32".

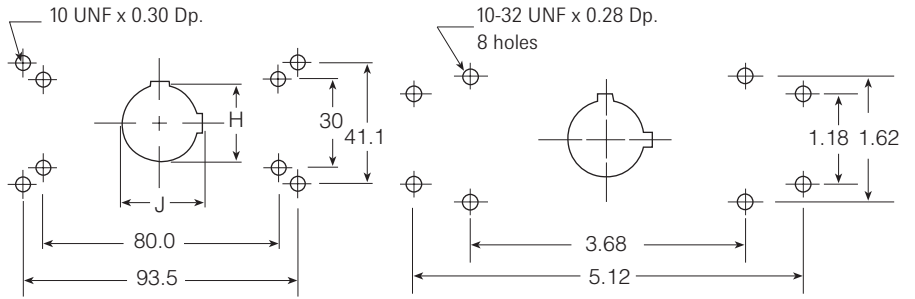
Actuator dimensions (inches)

| Size | A | B | C | D | E | F | Bottom of shaft | | | Top of shaft | | | Mounting holes | |
|------|----------------------|-------|-------|------|------|------|-----------------|------|------|--------------|------|------|-------------------------|------|
| | | | | | | | H | J | Key | H | J | Key | No x size | PCD |
| 004 | 6.77 | 3.66 | 3.66 | 2.5 | 3.03 | 2.95 | 0.81 | 0.85 | 0.19 | 0.81 | 0.85 | 0.19 | 4 x 1/4-20UNC x 0.38 Dp | 1.75 |
| | | | | | | | | | | | | | 4 x 3/8-16UNC x 0.56 Dp | 3.25 |
| 009 | 7.67 | 4.8 | 4.8 | 2.5 | 4.17 | 3.15 | 1 | 1.06 | 0.25 | 1 | 1.06 | 0.25 | 4 x 3/8-16UNC x 0.56 Dp | 3.25 |
| 014 | 8.11 | 5.43 | 5.22 | 2.5 | 4.59 | 3.15 | 1 | 1.06 | 0.25 | 1 | 1.06 | 0.25 | 4 x 3/8-16UNC x 0.56 Dp | 3.25 |
| 025 | 9.53 | 6.42 | 6.1 | 2.5 | 5.64 | 4.4 | 1.12 | 1.25 | 0.25 | 1.12 | 1.25 | 0.25 | 4 x 3/8-16UNC x 0.56 Dp | 3.25 |
| | | | | | | | | | | | | | 4 x 1/2-13UNC x 0.63 Dp | 5 |
| 037 | 11.22 | 7.26 | 6.59 | 2.85 | 6.44 | 4.57 | 1.12 | 1.25 | 0.25 | 1.12 | 1.25 | 0.25 | 4 x 3/8-16UNC x 0.56 Dp | 3.25 |
| | | | | | | | | | | | | | 4 x 1/2-13UNC x 0.63 Dp | 5 |
| 045 | 13.13 | 7.87 | 7.12 | 2.95 | 6.87 | 4.57 | 1.12 | 1.25 | 0.25 | 1.12 | 1.25 | 0.25 | 4 x 3/8-16UNC x 0.56 Dp | 3.25 |
| | | | | | | | | | | | | | 4 x 1/2-13UNC x 0.63 Dp | 5 |
| 070 | 15.51 | 9.05 | 8.35 | 3.5 | 8.07 | 5 | 1.62 | 1.81 | 0.37 | 1.12 | 1.25 | 0.25 | 4 x 1/2-13UNC x 0.63 Dp | 5 |
| 088 | 16.44 | 10 | 9.13 | 3.86 | 8.72 | 5.9 | 1.88 | 2.06 | 0.5 | 1.12 | 1.25 | 0.25 | 4 x 1/2-13UNC x 0.63 Dp | 5 |
| | | | | | | | | | | | | | 4 x 3/4-10UNC x 0.63 Dp | 6.5 |
| 180 | 18.93 ⁽¹⁾ | 11.10 | 10.47 | 5.12 | 9.84 | 7.48 | 1.88 | 2.06 | 0.5 | 1.12 | 1.25 | 0.25 | 4 x 3/4-10UNC x 1.0 Dp | 6.5 |
| 181 | 18.93 ⁽¹⁾ | 11.10 | 10.47 | 5.12 | 9.84 | 7.48 | 2.25 | 2.43 | 0.5 | 1.12 | 1.25 | 0.25 | 4 x 3/4-10UNC x 1.0 Dp | 6.5 |

Note:

1. 8 x 10 UNF x 0.30 Dp

Top mount drilling (Note 1) inches

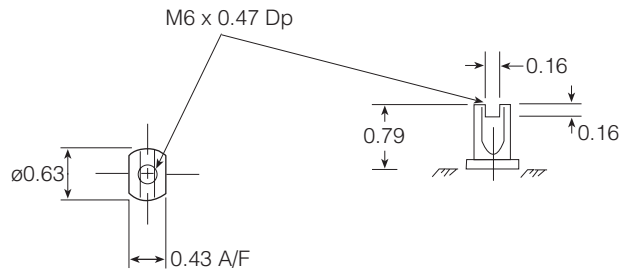


Top mounting drilling sizes 065 to 180/181

Note:

2. Full compliance to this specification is achieved with the addition of an optional male insert fitted to the top drive.

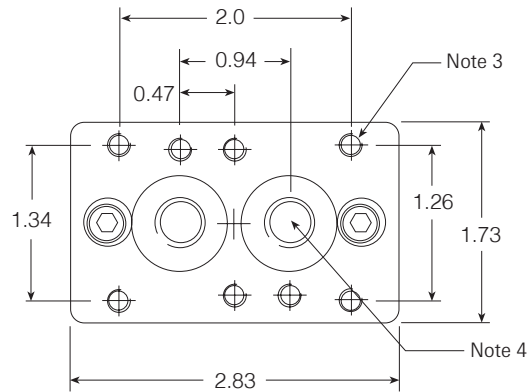
VDI/VDE 3845 mounting (Note 2) inches



Notes:

3. 8 x 10 UNF x 0.30 Dp
4. 2 x 1/4" NPT x 0.45 Dp

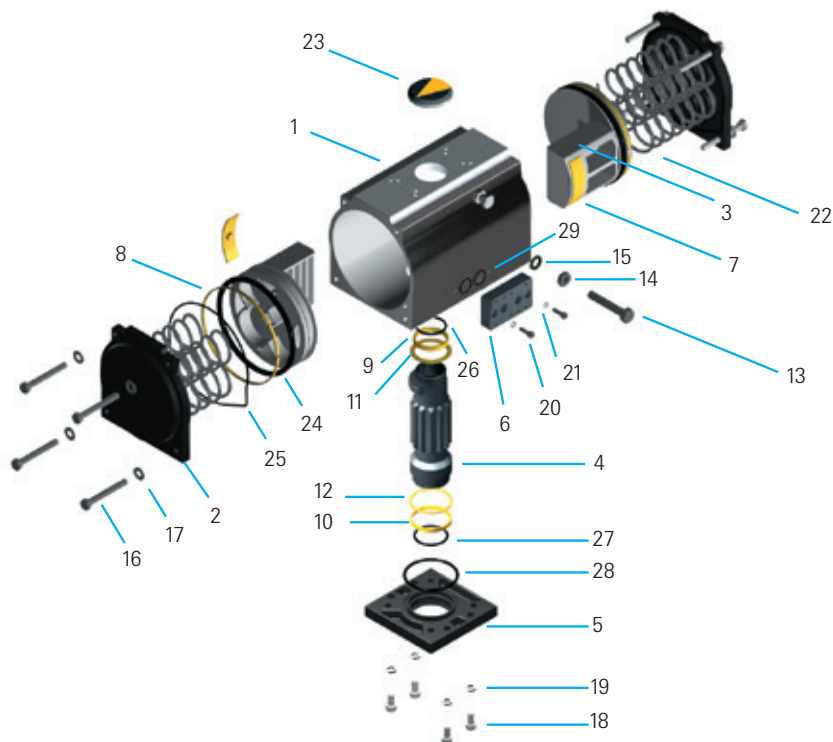
Air connection (Solenoid) plate (Notes 3, 4) inches



| Weight (lbs) | | |
|---------------|---------------|---------------|
| Actuator size | Double acting | Spring return |
| 004 | 4.2 | 4.4 |
| 009 | 7.5 | 8.4 |
| 014 | 9.7 | 10.8 |
| 025 | 16.0 | 18.0 |
| 037 | 23.3 | 25.3 |
| 045 | 33.0 | 35.2 |
| 070 | 42.0 | 48.0 |
| 088 | 77.0 | 88.0 |
| 180/181 | 99.0 | 158.4 |

| Air consumption volumes (at specified pressure) | | | | |
|---|------------|--------|-----------------------------------|--------|
| Actuator size | On opening | | On closing (Double acting models) | |
| | cu. in. | litres | cu. in. | litres |
| 004 | 15.1 | 0.25 | 9.4 | 0.15 |
| 009 | 31.9 | 0.52 | 21.2 | 0.35 |
| 014 | 45.5 | 0.75 | 31 | 0.51 |
| 025 | 78.5 | 1.29 | 55 | 0.9 |
| 037 | 115.6 | 1.9 | 79.9 | 1.31 |
| 045 | 156.1 | 2.56 | 105.8 | 1.74 |
| 070 | 245.2 | 4.02 | 165.9 | 2.72 |
| 088 | 292.5 | 4.8 | 196.7 | 3.23 |
| 180/181 | 590.7 | 9.7 | 408 | 6.7 |

Materials of construction



Materials of construction

| No. | Item | Material | US material std. | DIN/BS material std. | Finish |
|-----|-----------------------------|---------------------|------------------|----------------------|----------------------|
| 1 | Body | Extruded aluminum | ASTM B221 | BS 1474 6000 T5/6 | Hard anodize + ESPC* |
| 2 | End cap | Die cast aluminum | ASTM B85 | DIN 1725-231 | Chromate + ESPC* |
| 3 | Piston | Die cast aluminum | ASTM B85 | DIN 1725-231 | Anodize |
| 4 | Pinion shaft | Carbon steel | ASTM A108 | BS 970: 1983 212A42 | Nitrotech™** |
| 5 | Base plate | Die cast aluminum | ASTM B85 | DIN 1725-231 | Chromate + ESPC* |
| 6 | Air connection plate | Die cast aluminum | ASTM B85 | DIN 1725-231 | Chromate + ESPC* |
| 7 | Piston backing pad | Devlon-V™ | | | Natural |
| 8 | Piston support ring | Devlon-V™ | | | Natural |
| 9 | Top bearing | Devlon-V™ | | | Natural |
| 10 | Bottom bearing | Devlon-V™ | | | Natural |
| 11 | Top spacer | Devlon-V™ | | | Natural |
| 12 | Bottom spacer | Devlon-V™ | | | Natural |
| 13 | Stop bolt | 304 Stainless steel | ASTM A193 | BS 3692-A2-304 | Natural |
| 14 | Lock nut | 304 Stainless steel | ASTM A193 | BS 3692-A2-304 | Natural |
| 15 | Sealing washer | 304 Stainless steel | ASTM A193 | BS 4320-A2-304 | Natural |
| 16 | End cap bolt | 304 Stainless steel | ASTM A193 | BS 3692-A2-304 | Natural |
| 17 | End cap washer | 304 Stainless steel | ASTM A193 | BS 4320-A2-304 | Natural |
| 18 | Base plate bolt | 304 Stainless steel | ASTM A193 | BS 3692-A2-304 | Natural |
| 19 | Base plate washer | 304 Stainless steel | ASTM A193 | BS 4320-A2-304 | Natural |
| 20 | Air connection plate bolt | 304 Stainless steel | ASTM A193 | BS 3692-A2-304 | Natural |
| 21 | Air connection plate washer | 304 Stainless steel | ASTM A193 | BS 4320-A2-304 | Natural |
| 22 | Spring | Spring steel | ASTM A877 | BS 2806 685 A55 HDR3 | Oil dip |
| 23 | Indicator | ABS | | | Natural |
| 24 | Piston O-ring | Rubber-NBR or FPM | | | Natural |
| 25 | End cap O-ring | Rubber-NBR or FPM | | | Natural |
| 26 | Shaft top O-ring | Rubber-NBR or FPM | | | Natural |
| 27 | Shaft bottom O-ring | Rubber-NBR or FPM | | | Natural |
| 28 | Base plate O-ring | Rubber-NBR or FPM | | | Natural |
| 29 | Air connection plate O-ring | Rubber-NBR or FPM | | | Natural |

Notes:

* ESPC = Electrostatic powder coating

** Nitrotech™ = Proprietary corrosion resistant finish

Specifications

| Torque output (lbs. ins) – Double acting models | | | | | | | |
|---|--------------------|-------|-------|-------|-------|-------|-------|
| Actuator size | Air pressure (psi) | | | | | | |
| | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 004 | 204 | 260 | 315 | 370 | 425 | 481 | 536 |
| 009 | 460 | 584 | 709 | 833 | 957 | 1082 | 1206 |
| 014 | 674 | 856 | 1038 | 1221 | 1403 | 1585 | 1767 |
| 025 | 1196 | 1519 | 1842 | 2166 | 2489 | 2812 | 3135 |
| 037 | 1737 | 2206 | 2676 | 3145 | 3615 | 4084 | 4554 |
| 045 | 2301 | 2922 | 3544 | 4166 | 4788 | 5409 | 6031 |
| 070 | 3606 | 4581 | 5556 | 6531 | 7505 | 8480 | 9055 |
| 088 | 4277 | 5432 | 6588 | 7744 | 8900 | 10056 | 11211 |
| 180/181 | 8736 | 11097 | 13458 | 15818 | 18180 | 20405 | 22902 |

Notes

Double acting models

Using the chart opposite, select the actuator, which will provide the nearest torque output above the anticipated torque of the valve (+ safety factor).

Spring return models

Determine the desired 'failure mode' (fail open or fail closed), then determine the critical torque points for the subject valve using the table below. Using the chart opposite, select the appropriate spring rating (far right columns), according to the air supply pressure. Select the actuator which will provide the nearest torque output (both 'start' and 'end of spring') above the anticipated valve torque (+ safety factor).

Torque output (lbs. ins) – Spring return models

| Actuator size | Air pressure (psi) | | | | | | | | |
|---------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|---------------|
| | 40 Start - end air | 50 Start - end air | 60 Start - end air | 70 Start - end air | 80 Start - end air | 90 Start - end air | 100 Start - end air | Start - end spring | Spring rating |
| 004 | 119 - 71 | 174 - 126 | 229 - 182 | 285 - 237 | 340 - 292 | 395 - 347 | 450 - 403 | 117 - 69 | 40 |
| | 98 - 38 | 153 - 93 | 208 - 148 | 263 - 203 | 319 - 259 | 374 - 314 | 429 - 369 | 150 - 90 | 50 |
| | | 131 - 60 | 187 - 115 | 242 - 170 | 297 - 225 | 352 - 281 | 408 - 336 | 183 - 112 | 60 |
| | | 110 - 26 | 165 - 82 | 221 - 137 | 276 - 192 | 331 - 247 | 386 - 303 | 217 - 133 | 70 |
| | | | 144 - 48 | 199 - 103 | 254 - 159 | 310 - 214 | 365 - 269 | 250 - 154 | 80 |
| | | | 123 - 15 | 178 - 70 | 233 - 125 | 288 - 181 | 344 - 236 | 283 - 176 | 90 |
| | | | 156 - 37 | 212 - 92 | 267 - 147 | 322 - 203 | 317 - 197 | 100 | |
| 009 | 267 - 154 | 391 - 278 | 515 - 402 | 640 - 527 | 764 - 651 | 888 - 775 | 1013 - 900 | 269 - 156 | 40 |
| | 218 - 77 | 343 - 201 | 467 - 326 | 591 - 450 | 716 - 574 | 840 - 699 | 964 - 823 | 346 - 204 | 50 |
| | | 294 - 125 | 419 - 249 | 543 - 373 | 667 - 498 | 792 - 622 | 916 - 746 | 422 - 253 | 60 |
| | | 246 - 48 | 370 - 172 | 495 - 297 | 619 - 421 | 743 - 545 | 868 - 670 | 499 - 301 | 70 |
| | | | 322 - 96 | 446 - 220 | 571 - 344 | 695 - 469 | 819 - 593 | 576 - 349 | 80 |
| | | | 274 - 19 | 398 - 143 | 522 - 268 | 647 - 392 | 771 - 516 | 652 - 398 | 90 |
| | | | 350 - 67 | 474 - 191 | 598 - 315 | 723 - 440 | 729 - 446 | 100 | |
| 014 | 386 - 237 | 568 - 419 | 750 - 601 | 933 - 783 | 1115 - 965 | 1297 - 1148 | 1479 - 1330 | 383 - 233 | 40 |
| | 314 - 127 | 496 - 309 | 678 - 492 | 861 - 674 | 1043 - 856 | 1225 - 1038 | 1407 - 1220 | 492 - 305 | 50 |
| | | 424 - 200 | 606 - 382 | 789 - 564 | 971 - 747 | 1153 - 929 | 1335 - 1111 | 602 - 377 | 60 |
| | | 352 - 91 | 534 - 273 | 717 - 455 | 899 - 637 | 1081 - 819 | 1263 - 1002 | 711 - 449 | 70 |
| | | | 463 - 163 | 645 - 346 | 827 - 528 | 1009 - 710 | 1191 - 892 | 820 - 521 | 80 |
| | | | 391 - 54 | 573 - 236 | 755 - 418 | 937 - 601 | 1119 - 783 | 930 - 593 | 90 |
| | | | 501 - 127 | 683 - 309 | 865 - 491 | 1047 - 673 | 1039 - 665 | 100 | |
| 025 | 712 - 386 | 1035 - 709 | 1358 - 1032 | 1681 - 1356 | 2005 - 1679 | 2328 - 2002 | 2651 - 2325 | 713 - 387 | 40 |
| | 591 - 183 | 914 - 507 | 1237 - 830 | 1560 - 1153 | 1884 - 1476 | 2207 - 1799 | 2530 - 2123 | 916 - 508 | 50 |
| | | 793 - 304 | 1116 - 627 | 1439 - 951 | 1763 - 1274 | 2086 - 1597 | 2409 - 1920 | 1118 - 629 | 60 |
| | | 672 - 102 | 995 - 425 | 1318 - 748 | 1642 - 1071 | 1965 - 1394 | 2288 - 1718 | 1321 - 750 | 70 |
| | | | 1842 - 874 | 1197 - 546 | 1521 - 869 | 1844 - 1192 | 2167 - 1515 | 1523 - 871 | 80 |
| | | | 753 - 20 | 1076 - 343 | 1400 - 666 | 1723 - 989 | 2046 - 1313 | 1726 - 992 | 90 |
| | | | 955 - 141 | 1278 - 464 | 1602 - 787 | 1925 - 1110 | 1928 - 1113 | 100 | |
| 037 | 1030 - 577 | 1500 - 1046 | 1969 - 1516 | 2430 - 1985 | 2908 - 2455 | 3378 - 2924 | 3847 - 3394 | 1019 - 566 | 40 |
| | 854 - 287 | 1323 - 756 | 1793 - 1226 | 2262 - 1695 | 2731 - 2165 | 3201 - 2634 | 3670 - 3104 | 1309 - 742 | 50 |
| | | 1146 - 466 | 1616 - 936 | 2085 - 1405 | 2555 - 1875 | 3024 - 2344 | 3494 - 2814 | 1599 - 919 | 60 |
| | | 970 - 176 | 1439 - 646 | 1909 - 1115 | 2378 - 1585 | 2848 - 2054 | 3317 - 2524 | 1889 - 1096 | 70 |
| | | | 1263 - 356 | 1732 - 825 | 2201 - 1295 | 2671 - 1764 | 3140 - 2234 | 2179 - 1272 | 80 |
| | | | 1086 - 66 | 1555 - 535 | 2025 - 1005 | 2494 - 1474 | 2964 - 1944 | 2469 - 1449 | 90 |
| | | | 1379 - 245 | 1848 - 715 | 2318 - 1184 | 2787 - 1654 | 2759 - 1626 | 100 | |
| 045 | 1338 - 815 | 1960 - 1437 | 2582 - 2059 | 3204 - 2680 | 3825 - 3302 | 4447 - 3924 | 5069 - 4546 | 1299 - 776 | 40 |
| | 1098 - 444 | 1720 - 1066 | 2341 - 1687 | 2963 - 2309 | 3585 - 2931 | 4207 - 3553 | 4828 - 4174 | 1670 - 1016 | 50 |
| | 857 - 72 | 1479 - 694 | 2101 - 1316 | 2723 - 1938 | 3344 - 2559 | 3966 - 3181 | 4588 - 3803 | 2042 - 1257 | 60 |
| | | 1239 - 323 | 1860 - 945 | 2482 - 1566 | 3104 - 2188 | 3726 - 2810 | 4347 - 3422 | 2413 - 1497 | 70 |
| | | | 1620 - 573 | 2242 - 1195 | 2863 - 1817 | 3485 - 2439 | 4107 - 3060 | 2784 - 1738 | 80 |
| | | | 1379 - 202 | 2001 - 824 | 2623 - 1445 | 3245 - 2067 | 3866 - 2689 | 3156 - 1978 | 90 |
| | | | 1760 - 452 | 2382 - 1074 | 3004 - 1696 | 3626 - 2318 | 3527 - 2219 | 100 | |
| 070 | 2078 - 1293 | 3052 - 2268 | 4027 - 3242 | 5002 - 4217 | 5977 - 5192 | 6951 - 6167 | 7926 - 7141 | 2021 - 1236 | 40 |
| | 1696 - 715 | 2670 - 1689 | 3645 - 2664 | 4620 - 3639 | 5594 - 4613 | 6569 - 5588 | 7544 - 6563 | 2599 - 1618 | 50 |
| | 1313 - 136 | 2288 - 1111 | 3263 - 2086 | 4238 - 3060 | 5212 - 4035 | 6187 - 5010 | 7162 - 5985 | 3178 - 2001 | 60 |
| | | 1906 - 533 | 2881 - 1507 | 3855 - 2482 | 4830 - 3457 | 5805 - 4431 | 6780 - 5406 | 3756 - 2383 | 70 |
| | | | 2499 - 929 | 3473 - 1904 | 4448 - 2878 | 5423 - 3853 | 6397 - 4828 | 4334 - 2765 | 80 |
| | | | 2116 - 351 | 3091 - 1325 | 4066 - 2300 | 5040 - 3275 | 6015 - 4247 | 4913 - 3147 | 90 |
| | | | 2709 - 747 | 3684 - 1722 | 4658 - 2696 | 5633 - 3671 | 5491 - 3529 | 100 | |
| 088 | 2473 - 1460 | 3629 - 2616 | 4784 - 3772 | 5940 - 4928 | 7096 - 6083 | 8252 - 7239 | 9408 - 8395 | 2470 - 1457 | 40 |
| | 2022 - 756 | 3178 - 1912 | 4334 - 3068 | 5489 - 4224 | 6645 - 5379 | 7801 - 6535 | 8957 - 7691 | 3174 - 1908 | 50 |
| | 1571 - 52 | 2727 - 1208 | 3883 - 2364 | 5038 - 3519 | 6194 - 4675 | 7350 - 5831 | 8506 - 6987 | 3878 - 2359 | 60 |
| | | 2276 - 504 | 3432 - 1660 | 4587 - 2815 | 5743 - 3971 | 6899 - 5127 | 8055 - 6283 | 4582 - 2810 | 70 |
| | | | 2981 - 956 | 4137 - 2111 | 5292 - 3267 | 6488 - 4423 | 7604 - 5579 | 5286 - 3261 | 80 |
| | | | 2530 - 251 | 3686 - 1407 | 4841 - 2563 | 5997 - 3719 | 7153 - 4875 | 5990 - 3712 | 90 |
| | | | 3235 - 703 | 4391 - 1859 | 5546 - 3015 | 6702 - 4171 | 6694 - 4163 | 100 | |
| 180/181 | 4389 - 2122 | 6750 - 4482 | 9111 - 6843 | 11472 - 9204 | 13833 - 11565 | 16193 - 13926 | 18554 - 16286 | 5905 - 3637 | 40 |
| | | 5664 - 2829 | 8025 - 5190 | 10385 - 7551 | 12746 - 9911 | 15107 - 12272 | 17468 - 14633 | 7558 - 4724 | 50 |
| | | | 6938 - 3537 | 9299 - 5897 | 11660 - 8258 | 14021 - 10619 | 16381 - 12980 | 9212 - 5810 | 60 |
| | | | | 8213 - 4244 | 10573 - 6605 | 12934 - 8966 | 15295 - 11326 | 10865 - 6896 | 70 |
| | | | | | 9487 - 4952 | 11848 - 7312 | 14209 - 9673 | 12518 - 7983 | 80 |
| | | | | | | 10762 - 5659 | 13122 - 8020 | 14171 - 9069 | 90 |
| | | | | | | 12036 - 6367 | 15825 - 10155 | 100 | |

Critical torque points

Butterfly valves 'fail closed'

- Start of air torque
- End of spring torque

Butterfly valves 'fail open'

- Start of spring torque
- End of air torque

Ball valves 'fail closed'

- Start of air (unseating) torque
- End of air (full open) torque
- Start of spring (breakout from open) torque
- End of spring (re-seating) torque

Ball valves 'fail open'

- Start of spring (unseating) torque
- End of spring (full open) torque
- Start of air (breakout from open) torque
- End of air (re-seating) torque

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