numatics®

Actuators

R Series

Rack and Pinion Style Rotary Actuator Line

We're everywhere you need us to be!

R Series

R Series
Rotary Actuator

The **R Series** is a heavy-duty rack and pinion style rotary actuator that is designed to excel in the most rigid applications. The R Series includes a high torque-to-size ratio as well as accurate positioning.

Rack and Pinion
The **rack** and **pinion** is made from high strength alloy steel. It is induction hardened for long life. The geometry factors of the rack and pinion have been balanced to ensure equal wear, which provides maximum gear life. The pinion shaft includes a male key as standard offering.

Ball Bearings
The **ball bearings** are sealed and pre-lubed in an effort to prevent contamination from negatively affecting the operation. They are sized to except high loads and still retain smooth maintenance free operation.

Rack Bushing
The **rack bushing** is made from bearing bronze. The durability of the bushing enables it to support nearly the full length of the rack. Furthermore, we have included a small gap to allow grease/lubrication to be added.

Tube
The profile **tube** is hard coat anodized. The hard coating is an electro-chemical process, which produces a very dense surface of aluminum oxide. This surface has extreme hardness (60 RC.), excellent wear and corrosion resistance, and low coefficient of friction.

End Caps
The **end caps** are accurately machined from (6061-T6) solid aluminum bar stock. They are anodized for corrosion resistance. Additionally, port positioning is extremely flexible.

Rod Seal
The carboxilated nitrile with Teflon® compound **rod seals** is self-lubricating and durable. The rounded lip design ensures proper sealing and long life.

Tie Rods
The **tie rods** are 100,000 psi minimum yield steel for maximum holding power. They are roll formed for superior strength and engagement.

Piston
The solid aluminum alloy **piston** is strong and durable. A magnet groove is standard allowing for easy field conversation.

Piston Seal
The **piston seal** is a carboxilated nitrile with Teflon® compound for self-lubricating. The U-cup type seal construction is proven and durable.

Wear Band
The **wear band** is a stable, lubricating strip located on the piston.

Grease Opening
A 1/4-28 tapped hole (which is plugged) is provided for future installation of an optional grease fitting. Note that the unit is pre-lubed.
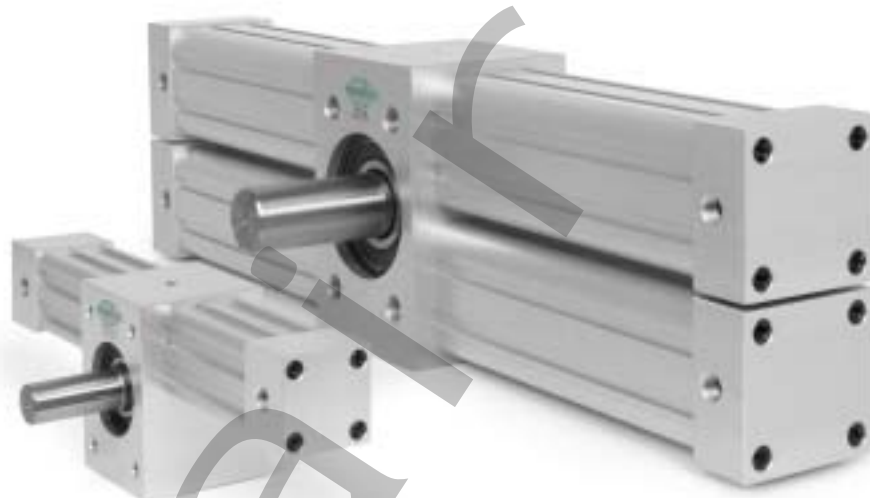
Teflon® is a registered trademark of DuPont™. For detailed information regarding the properties of Teflon®, please call 1-800-441-0573.

Standard Specifications:
• Bore sizes from 1" through 3-1/4"
• Nominal pressure rating is 150 psi air
• Standard rotations are: 45°, 90°, 180°, 270°, and 360°
• Minimum breakaway pressure: 5 psi non-cushioned, 10 psi cushioned
• Standard temperature -10°F to 165°F (-23°C to 74°C)
• NPTF ports
• Flexible port locating

The keyway at position 12:00, is always the mid-rotation of the actuator unless otherwise specified.

R Series
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numatics®
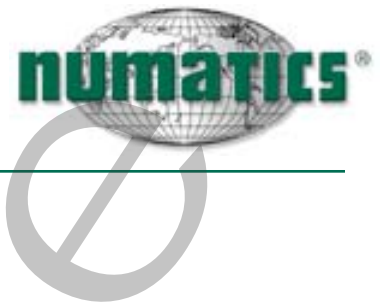
How to Order

S AR K - 180 1 C - C AA 0

Mounting
F = Front Flange
R = Rear Flange
P = Pilot Ring
B = Bottom Flange
S = Standard Mount

Type
AR = Single Rack
BR = Double Rack
CR = 3 Position Single Rack
DR* = 4 Position Single Rack
ER** = 5 Position Single Rack
* Must specify X dimension.
** Must specify X and Y dimensions.

Size
E = 1" Bore
K = 1-1/2" Bore
L = 2" Bore
M = 2-1/2" Bore
P = 3-1/4" Bore

Degrees Rotation
045 = 45°
090 = 90°
180 = 180°
270 = 270°
360 = 360°
Any degree of rotation can be specified.

Consult factory for rotations of or greater than 1000°.

Rod End Code
1 = Single Male Keyed (Std)
2 = Single Female Keyed
3 = Double Male Keyed
4 = Preloaded Keyway

Magnetic Piston
0 = No Magnet
2 = Magnet

Options
AA = No Options
BA = Bumpers Both Directions
BC = Bumpers Counterclockwise
BH = Bumpers Clockwise
KA = Angle Adjustment Both Directions
KC = Angle Adjustment Counterclockwise
KH = Angle Adjustment Clockwise
SA = Shock Absorbers Both Directions
SC = Shock Absorbers Counterclockwise
SH = Shock Absorbers Clockwise
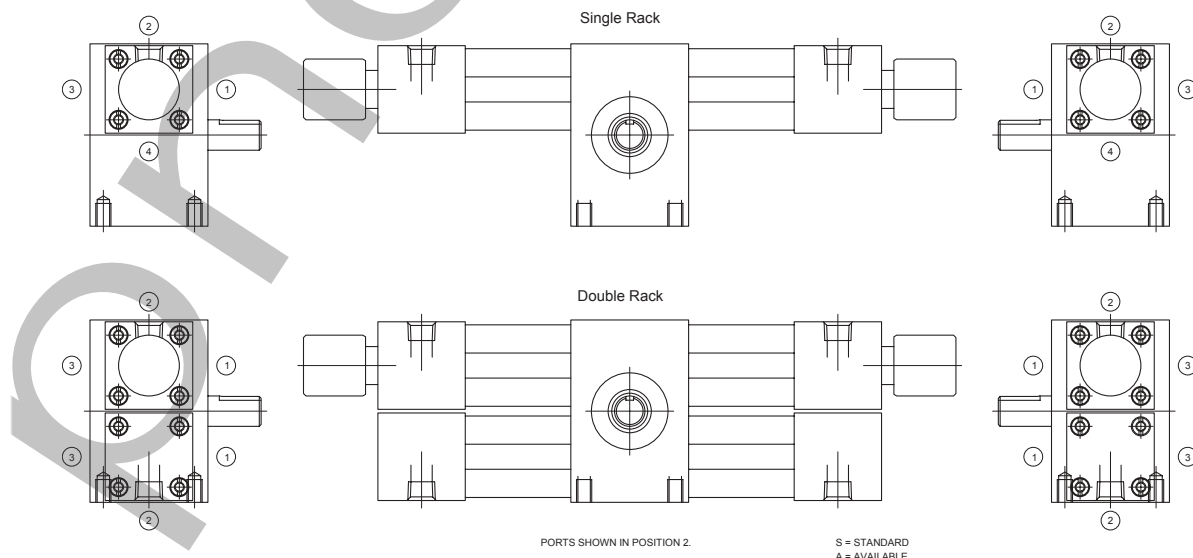SS = Shaft Seal Covers
VA = Viton Seals

Cushions

Position	Standard			
	1	2	3	4
No Cushions	A	A	A	A
CW and CCW	B	C	D	E
CW	F	G	H	J
CCW	K	L	M	N

CW = Clockwise
CCW = Counter-clockwise

Ports

Position	Size Code			
	1/8	1/4	3/8	1/2
1	B	C	D	E
2	H	I	J	K
3	N	O	P	Q
4	T	U	V	W

Cushion and Port Positions

Single Rack

Double Rack

PORTS SHOWN IN POSITION 2.

S = STANDARD
A = AVAILABLE

NOTE: Consult factory for repair kit information.

R Series
Rotary Actuator

Standard Specifications

Maximum operating pressure: 150 psi pneumatic

Standard rotations: 45˚, 90˚, 180˚, 270˚, 360˚ and other rotations optional
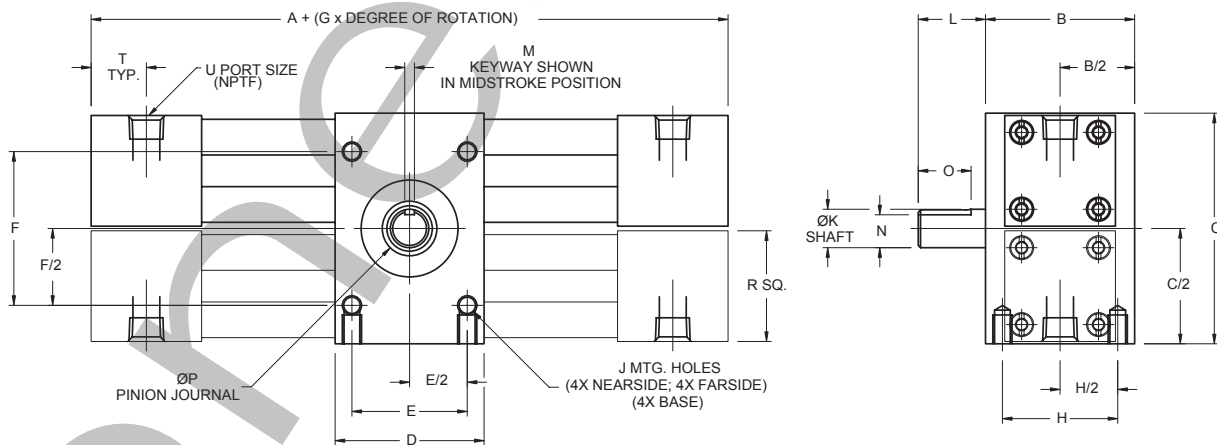
Maximum breakaway pressure: 5 psi non-cushion, 10 psi cushioned

Operating temperature: 0˚ F to 180˚ F (standard seals)
                      -20˚ F to 400˚ F (viton seals)

BORE	NUMBER OF RACKS	MODEL	THEORETICAL TORQUE OUTPUT (in-lbs)			DISPLACEMENT CU. IN./DEG. OF ROTATION	"MAX. ANGULAR BACKLASH, MINUTES"	MAX. ROTATIONAL TOTAL (DEGREES)
			50 psi	100 psi	150 psi			
1"	1	SARE	19	39	59	0.007	50	10
1"	2	SBRE	39	79	118	0.014	50	10
1 1/2"	1	SARK	59	118	177	0.021	40	8
1 1/2"	2	SBRK	118	236	353	0.042	40	8
2"	1	SARL	141	282	424	0.049	30	6
2"	2	SBRL	282	565	848	0.099	30	6
2 1/2"	1	SARM	276	552	828	0.096	30	6
2 1/2"	2	SBRM	552	1104	1656	0.193	30	6
3 1/4"	1	SARP	570	1141	1711	0.199	15	4
3 1/4"	2	SBRP	1141	2281	3422	0.398	15	4

Allow 10% for friction loss.

Standard Mount

Dimensions

| BORE	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	R	T	U	V
1	7 1/2	2	3	2	1.50	2.00	0.01746	1.50	1/4-20 X 3/8 DEEP	.500/.499	7/8	.125/.127	.430/.425	5/8	0.59	1 7/16	0.75	1/8	3/4
1 1/2	8 1/2	3	4 1/4	3	2.00	3.00	0.02328	2.00	5/16-18 X 1/2 DEEP	.875/.874	1 7/8	.188/.190	.771/.761	1 1/2	0.98	2	0.75	1/4	1 1/16
2	9 1/2	3	5	4	2.50	3.50	0.03124	2.00	3/8-16 X 1/2 DEEP	1.125/1.124	1 7/8	.250/.252	.986/.976	1 1/2	1.18	2 7/16	0.75	1/4	1 1/4
2 1/2	9 3/4	3 1/2	6	4	2.50	4.50	0.03926	2.00	1/2-13 X 3/4 DEEP	1.375/1.374	2 1/4	.313/.315	1.201/1.191	1 3/4	1.57	2 15/16	0.75	1/4	1 1/2
3 1/4	11 1/4	5	8	5	3.00	5.00	0.04800	2.50	3/4-10 X 1 DEEP	1.750/1.749	3 1/2	.375/.377	1.542/1.532	3	1.77	3 3/4	0.88	3/8	1 15/16

**R Series
Rotary Actuator**

Options

Rotation Adjust

Rotation adjusting knobs can be added to control rotation more precisely. They can be used on both ends or on either end individually. Rotation adjusters can be used in conjunction with cushions. Their "high tech" style makes rotation adjustment easy to do without tools. The metric set screw in the side of knob securely locks the rotation setting. Thus, the rotation is very easy to adjust, but cannot be changed without a metric allen wrench. When used with cushions, maximum rotation adjustment will still allow at least 20° of rotation to be in cushion.
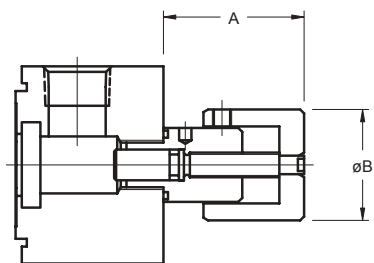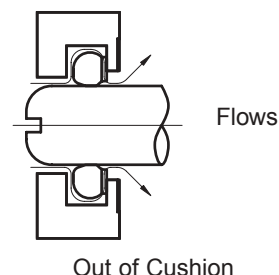
BORE	A	B	DEGREE OF ROTATION PER END
1	1.43	1.13	43
1 1/2	1.43	1.13	32
2	2.22	1.75	40
2 1/2	2.22	1.75	32
3 1/4	2.67	2.35	32

Cushions

Seals

Into Cushion
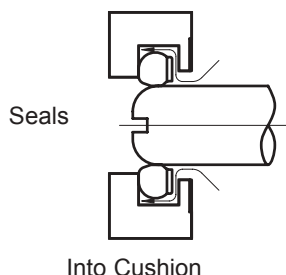
Our cushion seal has a built-in function. It seals in one direction and permits full flow in the opposite direction.

Flows

Out of Cushion

Cushions can be added to meter deceleration. Cushion adjustment needles can be put in any quadrant. Normally, cushions will be added to only one half of the double rack unit. The cushion and its operation is very similar to our current A series design. Rotation adjust can be used in conjunction with cushions. Cushions and Shock absorbers together are not available.

Bumpers

Bumper seals can be added to reduce impact. The bumper and seal are one piece. Bumpers can be used in conjunction with cushions if necessary.

NOTE: Cannot be used with rotation adjustment.
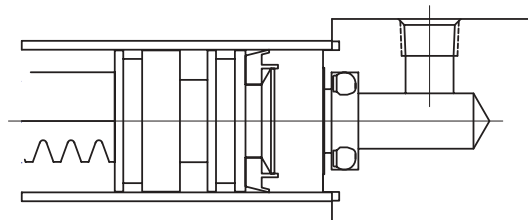
Shock Absorbers

Hydraulic shock absorbers can be added to reduce noise and large impacts. Shocks are fixed orifice self-compensating type. They can also be used for rotation adjust. The 3 1/4" bore rotary actuator will not have this option. Cushions and shock absorbers together are not available.
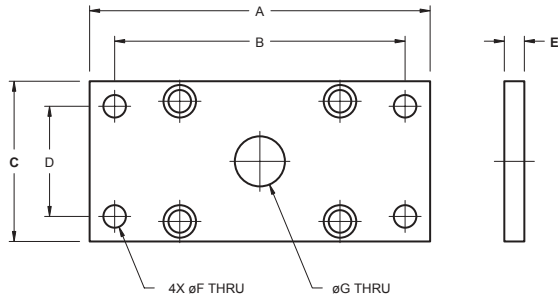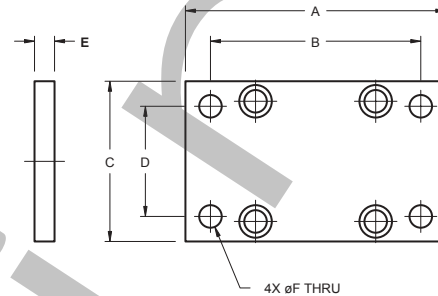
NOTE: Shock cannot be adjusted.
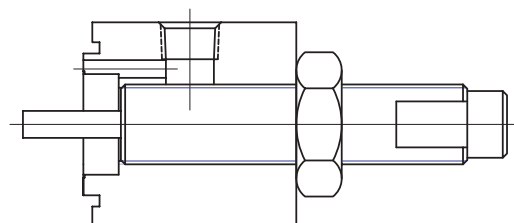
Mounting Options

Flanges

Front and Rear Flange

4X øF THRU

øG THRU

BORE	A	B	C	D	E	F	G
1	4.25	3.63	2	1.38	0.25	9/32	5/8
1 1/2	5.75	5.13	3	2.13	0.44	13/32	1
2	6.50	5.88	4	3.38	0.44	13/32	1 1/4
2 1/2	8.25	7.25	4	3.00	0.44	17/32	1 5/8
3 1/4	12.00	10.00	5	3.00	0.75	25/32	2

Bottom Flange

4X øF THRU

BORE	A	B	C	D	E	F
1	3.25	2.63	2	1.38	0.25	9/32
1 1/2	4.50	3.88	3	2.13	0.44	13/32
2	4.50	3.88	4	3.38	0.44	13/32
2 1/2	5.50	4.50	4	3.00	0.44	17/32
3 1/4	8.00	6.50	5	3.50	0.75	25/32

Shaft Seal Cover and Pilot Ring

$A \begin{smallmatrix} +.000 \\ -.002 \end{smallmatrix}$
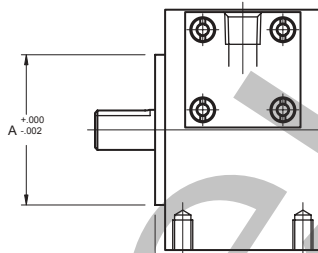
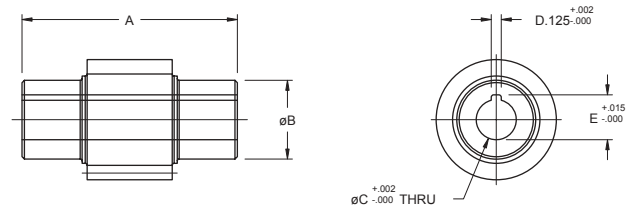| BORE	A	B
1	1.875	0.125
1 1/2	3.000	0.250
2	3.250	0.250
2 1/2	3.625	0.250
3 1/4	4.480	0.250

The pilot ring and the shaft seal cover are dimensionally the same. Pilot rings are used to help center the shaft to the work piece. Shaft seal covers are used to prevent contamination to the ball bearings. They can only be used on single and double male shafts.

Shaft Options

BORE	A	B	C	D	E
1	1.81	0.59	0.250	N/A	N/A
1 1/2	2.69	0.98	0.500	0.125	0.560
2	2.72	1.18	0.688	0.187	0.780
2 1/2	3.13	1.57	0.813	0.250	0.901
3 1/4	4.56	1.77	1.125	0.250	1.247

Double Male Keyed

L TYP.
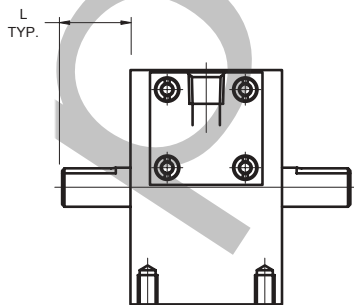
BORE	L
1	0.875
1 1/2	1.875
2	1.875
2 1/2	2.250
3 1/4	3.500

Single Female Keyed

$D.125 \begin{smallmatrix} +.002 \\ -.000 \end{smallmatrix}$

$E \begin{smallmatrix} +.015 \\ -.000 \end{smallmatrix}$

$øC \begin{smallmatrix} +.002 \\ -.000 \end{smallmatrix}$ THRU

Kinetic Energy Basic Formula

$$KE = 1/2 \, J\omega^2$$

$$\omega = 0.035 \times \frac{\text{Angle traveled (degrees)}}{\text{Rotation time (seconds)}}$$

Where:

KE	=	Kinetic Energy (in-lb)
J	=	Rotational mass moment of inertia (in-lb-sec^2) (Dependent on physical size of object and weight)
ω	=	Peak Velocity (rad/sec) (Assuming twice average velocity)
W	=	Weight of load (lb)
g	=	Gravitational constant = 386.4 in/sec^2
r	=	Radius of gyration (in)

Moments of Inertia
Maximum Kinetic Energy Rating for Models Based on Configuration (in-lb)

BORE	STANDARD	ROTATION ADJUSTERS	CUSHIONS	SHOCK ABSORBERS (PER CYCLE/PER HOUR)
1"	0.50	0.50	5	150/300,000
1 1/2"	2.00	2.00	20	225/400,000
2"	4.00	4.00	40	600/600,000
2 1/2"	7.00	7.00	70	600/600,000
3 1/4"	15.00	15.00	150	N/A

Thin Disk-End mounted on center

$$J = \frac{W}{g} \times \frac{r^2}{4}$$

Thin Disk- Mounted on center

$$J = \frac{W}{g} \times \frac{r^2}{2}$$

Point Load

$$J = \frac{W}{g} \times r^2$$

Thin Rectangular Plate- Mounted on center

$$J = \frac{W}{g} \times \frac{a^2}{12}$$

Thin Rectangular Plate

$$J = \frac{W1}{g} \times \frac{4a^2 + c^2}{12} + \frac{W2}{g} \times \frac{4b^2 + c^2}{12}$$

Slender Rod

$$J = \frac{W1}{g} \times \frac{a^2}{3} + \frac{W2}{g} \times \frac{b^2}{3}$$

ORDER ONLINE

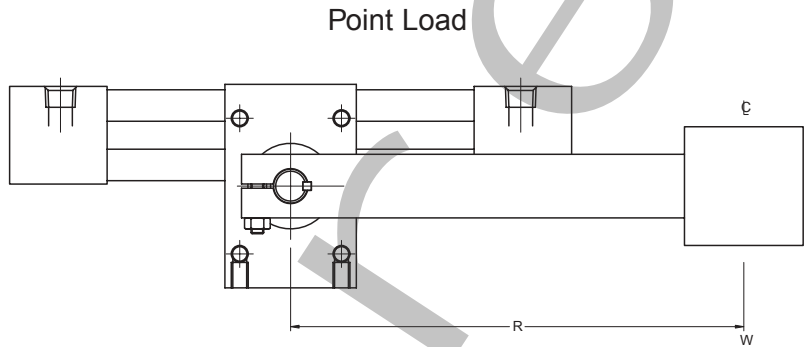# Size and Selection Example

Point load application
W=5 lb. load
r=12 inch arm length
Want to use 1 1/2 bore rotary actuator
Need to rotate 180 degrees in 2 seconds
Should I use bumpers, cushions, shocks, or none of these?

Point Load

From Catalog:

$$\omega = 0.035 \times \frac{\text{Angle traveled (DEG)}}{\text{Rotation time (SEC)}}$$

$$\omega = 0.035 \times \frac{180 \text{ DEG}}{2 \text{ SEC}}$$

$$\omega = \frac{3.15}{\text{SEC}}$$

$$J = \frac{W}{g} \times r^2$$

$$J = \frac{W}{g} \times r^2$$

$$J = 5 \text{ LB} \frac{\text{SEC}^2}{386.4 \text{ IN}} \times \text{IN}^2$$

$$J = 1.86 \text{ IN-LB-SEC}^2$$

$$KE = 1/2 \ J\omega^2$$

$$KE = \frac{1}{2} \times 1.86 \text{ IN-LB-SEC}^2 \times \left(\frac{3.15}{\text{SEC}}\right)^2$$

$$KE = 9.23 \text{ IN-LB}$$

Looking at Kinetic Energy Rating Chart:

Maximum KE=20 IN-LBS for a 1 1/2" bore rotary with cushions

Therefore, application requires cushions.

Maximum Kinetic Energy Rating
for Models Based on Configuration (in-lb)

BORE	STANDARD	STROKE ADJUSTERS	CUSHIONS	SHOCK ABSORBERS (PER CYCLE/PER HR.)
1	0.50	0.50	5	150/300,000
1 1/2	2.00	2.00	20	225/400,000
2	4.00	4.00	40	600/600,000
2 1/2	7.00	7.00	70	600/600,000
3 1/4	15.00	15.00	150	N/A

Specifications

Unit Weights (lbs)

MODEL	ROTATION (DEGREES)			
	90	180	270	360
SARE	3	3	3	3
SBRE	4	4	4	5
SARK	9	9	10	10
SBRK	12	13	14	15
SARL	14	15	16	17
SBRL	20	22	24	27
SARM	22	23	25	27
SBRM	31	34	38	41
SARP	45	47	49	52
SBRP	62	67	72	77

Bearing Load Capacities

BORE	RADIAL LOAD (lb)	THRUST LOAD (lb)	DISTANCE BETWEEN BEARINGS (in)
1	100	75	1.40
1 1/2	300	200	2.15
2	500	350	2.15
2 1/2	900	600	2.50
3 1/4	1300	900	3.75

Port and Cushion Locations

Single Rack

Double Rack

PORTS SHOWN IN POSITION 2.
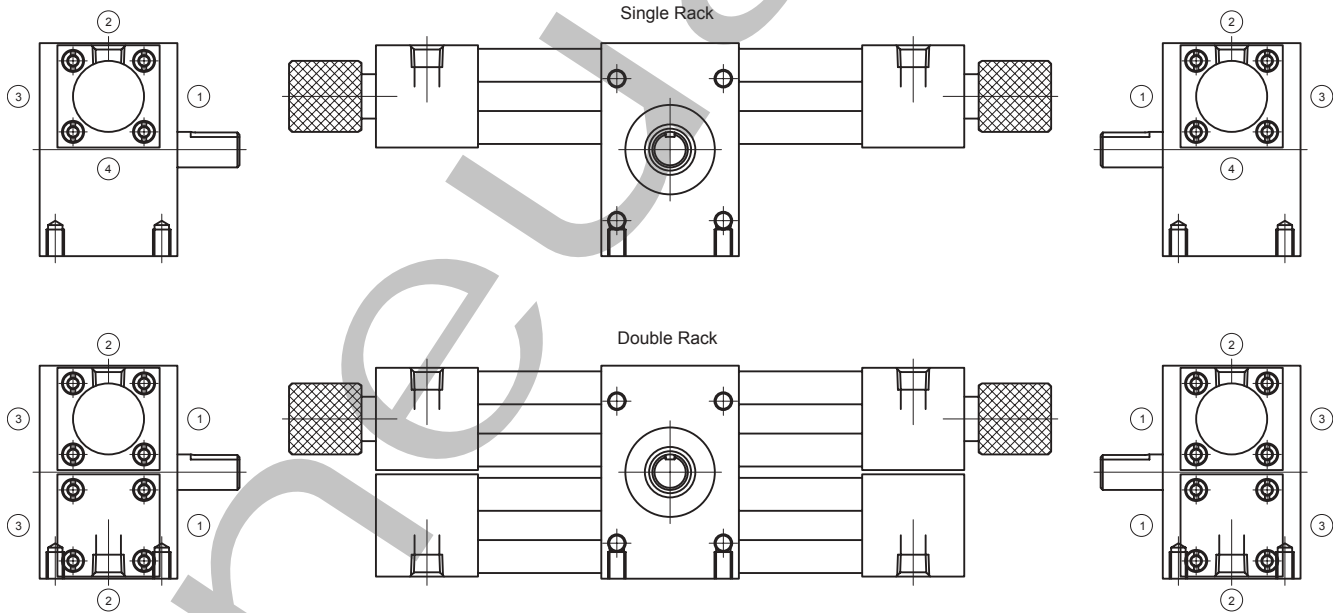
Standard port location is position 1. Standard cushion location is position 2. Ports and/or cushions in position 4 are only available on single rack rotary actuators.
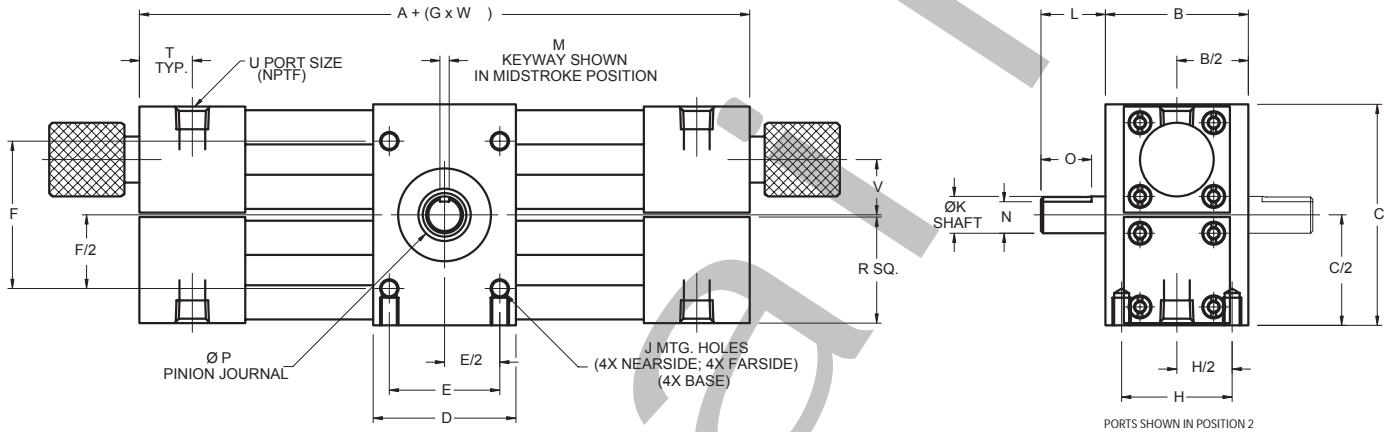
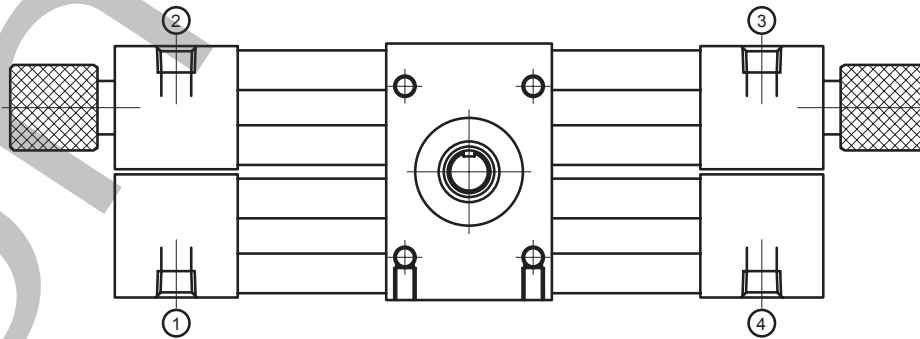| BORE SIZE	PORT SIZE			
	1/8	1/4	3/8	1/2
1	S	A	-	-
1 1/2	A	S	A	-
2	A	S	A	-
2 1/2	A	S	A	-
3 1/4	A	A	S	A

S=Standard
A=Available

Multi-position Rotary Actuator
3 Position

Our rotary actuators are available in various multi-position configurations. The following shows 3, 4 and 5 position types. Consult factory.
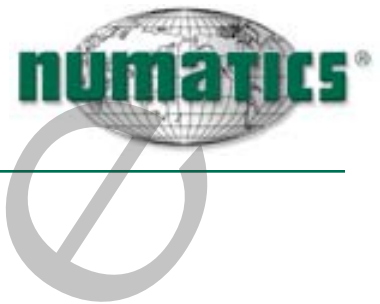

Dimensions

BORE	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	R	T	U	V
1	7 1/2	2	3	2	1.50	2.00	0.01746	1.50	1/4-20 X 3/8 DEEP	.500/.499	7/8	.125/.127	.430/.425	5/8	0.59	1 7/16	0.75	1/8	3/4
1 1/2	8 1/2	3	4 1/4	3	2.00	3.00	0.02328	2.00	5/16-18 X 1/2 DEEP	.875/.874	1 7/8	.188/.190	.771/.761	1 1/2	0.98	2	0.75	1/4	1 1/16
2	9 1/2	3	5	4	2.50	3.50	0.03124	2.00	3/8-16 X 1/2 DEEP	1.125/1.124	1 7/8	.250/.252	.986/.976	1 1/2	1.18	2 7/16	0.75	1/4	1 1/4
2 1/2	9 3/4	3 1/2	6	4	2.50	4.50	0.03926	2.00	1/2-13 X 3/4 DEEP	1.375/1.374	2 1/4	.313/.315	1.201/1.191	1 3/4	1.57	2 15/16	0.75	1/4	1 1/2
3 1/4	11 1/4	5	8	5	3.00	5.00	0.04800	2.50	3/4-10 X 1 DEEP	1.750/1.749	3 1/2	.375/.377	1.542/1.532	3	1.77	3 3/4	0.88	3/8	1 15/16

A three position rotary actuator provides one intermediate stopping position between the full counterclockwise and full clockwise position. The full counterclockwise position is achieved by pressurizing port 1. The intermediate position is achieved by pressurizing both ports 2 and 3. The final clockwise position is achieved by pressurizing port 4. Rotation adjustment for the full counterclockwise and full clockwise positions only are standard.
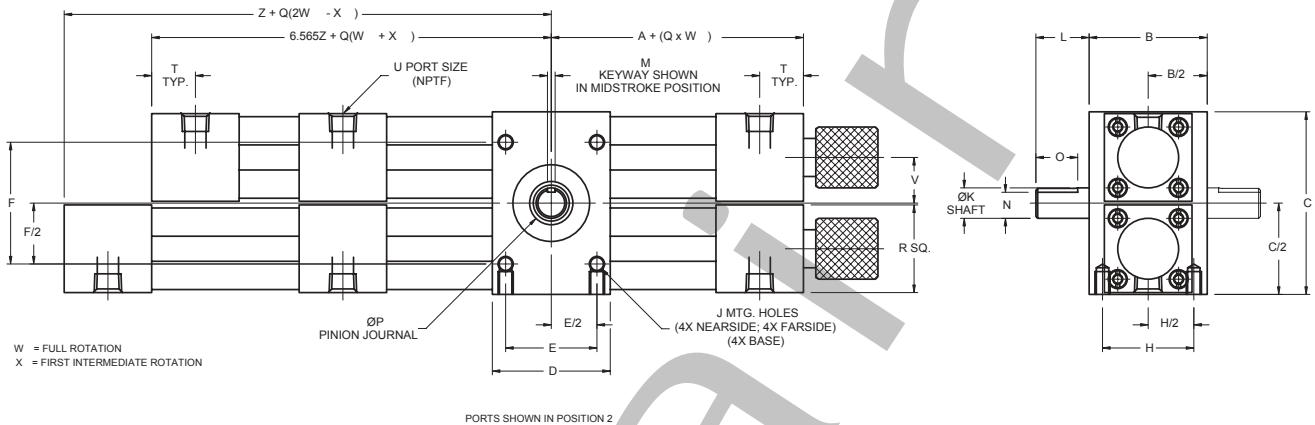
4 Position

W° = Full Rotation
X° = First Intermediate Rotation


W = FULL ROTATION
X = FIRST INTERMEDIATE ROTATION

PORTS SHOWN IN POSITION 2

Dimensions

BORE	A	B	C	D	E	F	H	J	K	L
1	3 3/4	2	3	2	1.50	2.00	1.50	1/4-20 X 3/8 DEEP	.500/.499	7/8
1 1/2	4 1/4	3	4 1/4	3	2.00	3.00	2.00	5/16-18 X 1/2 DEEP	.875/.874	1 7/8
2	4 3/4	3	5	4	2.50	3.50	2.00	3/8-16 X 1/2 DEEP	1.125/1.124	1 7/8
2 1/2	4 7/8	3 1/2	6	4	2.50	4.50	2.00	1/2-13 X 3/4 DEEP	1.375/1.374	2 1/4
3 1/4	5 5/8	5	8	5	3.00	5.00	2.50	3/4-10 X 1 DEEP	1.750/1.749	3 1/2

M	N	O	P	Q	R	T	U	V	Z
.125/.127	.430/.425	5/8	0.59	0.0085	1 7/16	0.75	1/8	3/4	6 7/8
.188/.190	.771/.761	1 1/2	0.98	0.0115	2	0.75	1/4	1 1/16	7 3/8
.250/.252	.986/.976	1 1/2	1.18	0.0155	2 7/16	0.75	1/4	1 1/4	7 7/8
.313/.315	1.201/1.191	1 3/4	1.57	0.0195	2 15/16	0.75	1/4	1 1/2	8 1/8
.375/.377	1.542/1.532	3	1.77	0.024	3 3/4	0.88	3/8	1 15/16	9 1/4
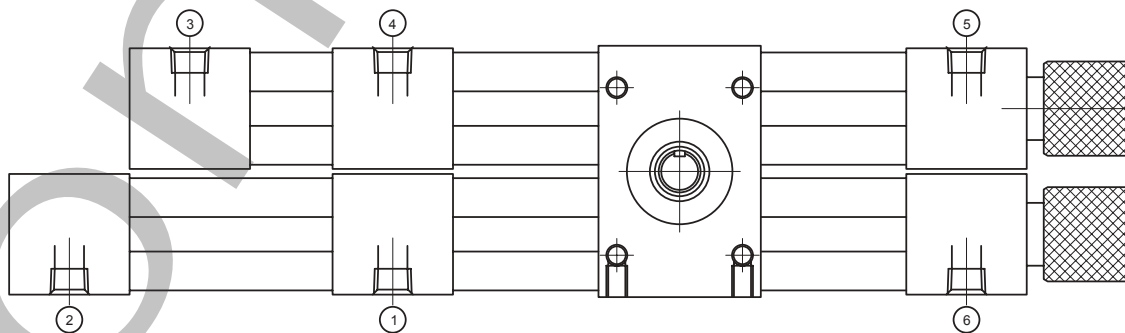
A four position rotary actuator provides two intermediate stopping positions between the full counterclockwise and full clockwise positions. The full counterclockwise position is achieved by pressurizing port 1. The first intermediate position is achieved by pressurizing both ports 2 and 3. The second intermediate position is achieved by pressurizing both ports 4 and 5. The final position is achieved by pressurizing port 6. Rotation adjustment for the full counterclockwise and full clockwise positions only are standard.
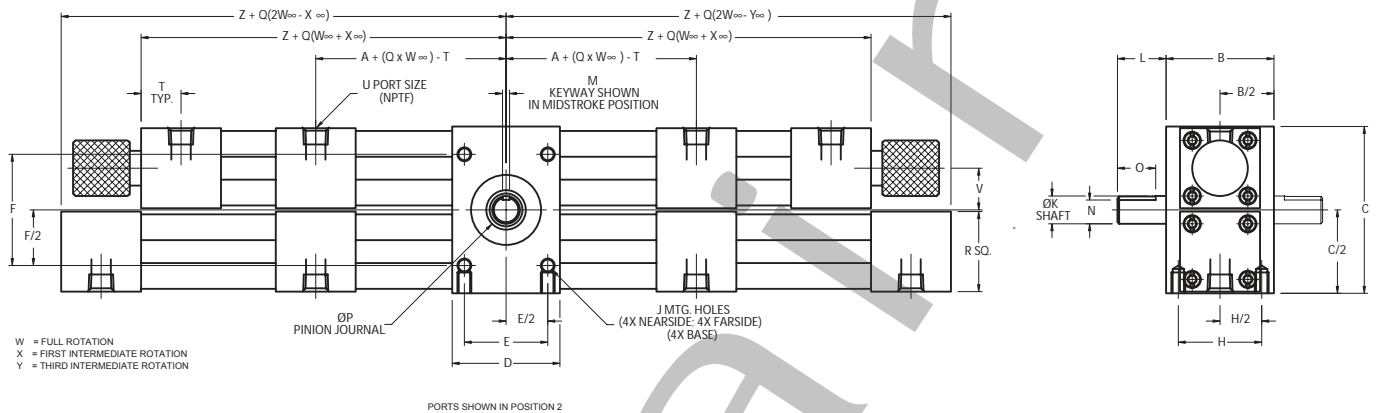
R Series
Rotary Actuator

5 Position

W° = Full Rotation
X° = First Intermediate Rotation
Y° = Third Intermediate Rotation

W = FULL ROTATION
X = FIRST INTERMEDIATE ROTATION
Y = THIRD INTERMEDIATE ROTATION

PORTS SHOWN IN POSITION 2

Dimensions

Bore	A	B	C	D	E	F	H	J	K	L
1	3 3/4	2	3	2	1.50	2.00	1.50	1/4-20 X 3/8 DEEP	.500/.499	7/8
1 1/2	4 1/4	3	4 1/4	3	2.00	3.00	2.00	5/16-18 X 1/2 DEEP	.875/.874	1 7/8
2	4 3/4	3	5	4	2.50	3.50	2.00	3/8-16 X 1/2 DEEP	1.125/1.124	1 7/8
2 1/2	4 7/8	3 1/2	6	4	2.50	4.50	2.00	1/2-13 X 3/4 DEEP	1.375/1.374	2 1/4
3 1/4	5 5/8	5	8	5	3.00	5.00	2.50	3/4-10 X 1 DEEP	1.750/1.749	3 1/2

M	N	O	P	Q	R	T	U	V	Z
.125/.127	.430/.425	5/8	0.59	0.0085	1 7/16	0.75	1/8	3/4	6 7/8
.188/.190	.771/.761	1 1/2	0.98	0.0115	2	0.75	1/4	1 1/16	7 3/8
.250/.252	.986/.976	1 1/2	1.18	0.0155	2 7/16	0.75	1/4	1 1/4	7 7/8
.313/.315	1.201/1.191	1 3/4	1.57	0.0195	2 15/16	0.75	1/4	1 1/2	8 1/8
.375/.377	1.542/1.532	3	1.77	0.0240	3 3/4	0.88	3/8	1 15/16	9 1/4
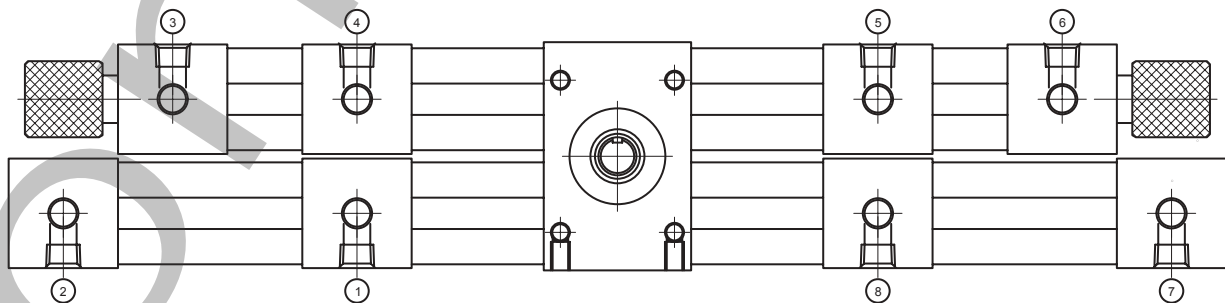
A five position rotary actuator provides three intermediate stopping positions between the full counterclockwise and full clockwise positions. The full counterclockwise position is achieved by pressurizing port 1. The first intermediate position is achieved by pressurizing both ports 2 and 3. The second intermediate position is achieved by pressurizing both ports 4 and 5. The third intermediate position is achieved by pressurizing both ports 6 and 7. The final clockwise position is achieved by pressurizing port 8. Rotation adjustment for the full counterclockwise and full clockwise positions only are standard.