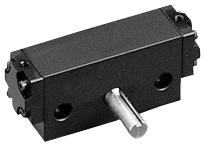
Rack and Pinion Rotary Actuators

Mini Rotary Actuators
- Mini Rack and Pinion Rotary Actuators 1/2" and 3/4" Bore Features.....ACT-12-2
- Mini Rack and Pinion Rotary Actuators 1/2" and 3/4" Bore Technical Features.....ACT-12-3
- Mini Rack and Pinion Rotary Actuators 1/2" and 3/4" Bore Special Options.....ACT-12-4
- Single Rack and Pinion Mini Rotary Actuators 1/2" and 3/4" Bore ACT-12-6
- Double Rack and Pinion Mini Rotary Actuators 1/2" and 3/4" Bore ACT-12-7
- Integral Air/Oil Tandem Double Rack and Pinion Mini Rotary Actuators 3/4" Bore..ACT-12-8
- Mini Rack and Pinion Rotary Actuators Order Information.....ACT-12-9

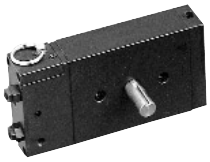
Rotary Actuators
- Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore Features.....ACT-12-10
- Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore Technical Features.....ACT-12-11
- Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore Special Options.....ACT-12-12
- Single Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore ACT-12-14
- Double Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore ACT-12-16
- Double Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore with Standard Air/Oil Tandem Option.....ACT-12-18
- Double Rack and Pinion Rotary Actuators 1-1/8" to 2-1/2" Bore with Integral Air/Oil Tandem Option.....ACT-12-18
- Multiple (3) Position Rack and Pinion Rotary Actuators ACT-12-19
- Multiple (4) Position Rack and Pinion Rotary Actuators ACT-12-19
- Multiple (5) Position Rack and Pinion Rotary Actuators ACT-12-19
- Rotary Actuators Order Information ACT-12-20

Switches.....ACT-12-21
Rotary Tables.....ACT-12-22
Calculating a Moment of Inertia.....ACT-12-26
Rotary Actuator Applications.....ACT-12-27



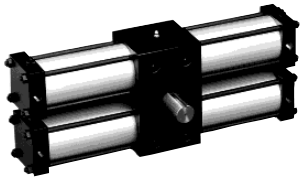
ACT-12-6 – Single Rack and Pinion Mini Rotary Actuator

ACT-12-7 – Double Rack and Pinion Mini Rotary Actuator



ACT-12-8 – Integral Air/Oil Tandem Double Rack and Pinion Mini Rotary Actuator

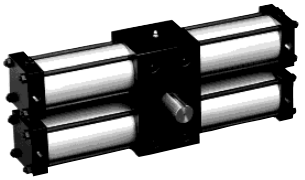
ACT-12-14 – Single Rack and Pinion Rotary Actuator



ACT-12-16 – Double Rack and Pinion Rotary Actuator

ACT-12-18 – Double Rack and Pinion Rotary Actuator with Standard Air/Oil Tandem Option

ACT-12-18 – Double Rack and PinionRotary Actuator with Integral Air/Oil Tandem Option



ACT-12-19 – Multiple (3, 4, and 5) Position Rack and Pinion Rotary Actuator

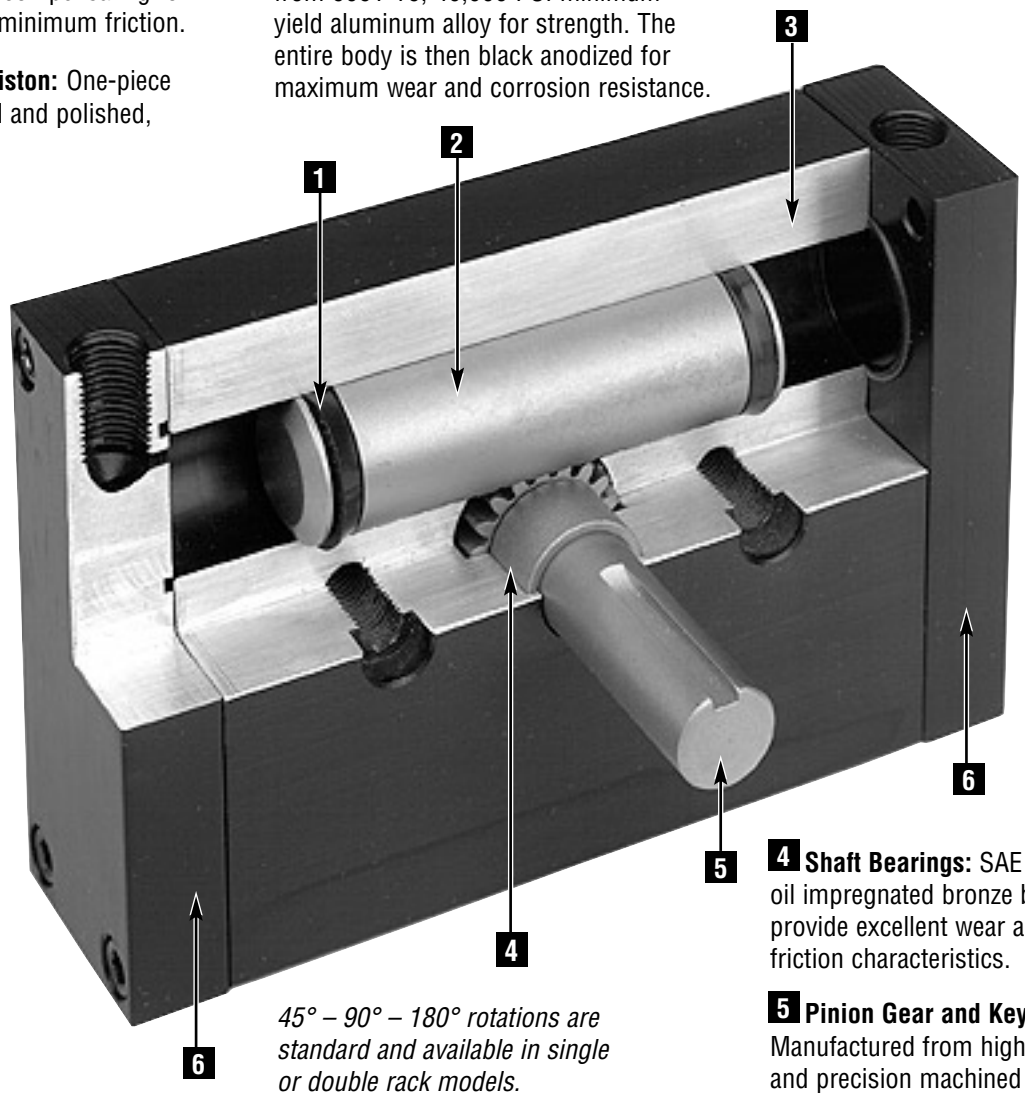
Mini Rotary Actuators are constructed with the finest materials for each component!

1 Seals: Lip type, pressure sensitive nitrile seals are wear compensating for long service life and minimum friction.

2 Gear Rack and Piston: One-piece construction, ground and polished, stress-proof steel.

3 Actuator Body: Precision machined from 6061-T6, 40,000 PSI minimum yield aluminum alloy for strength. The entire body is then black anodized for maximum wear and corrosion resistance.

Double Rack Shown



45° – 90° – 180° rotations are standard and available in single or double rack models.

4 Shaft Bearings: SAE 841 oil impregnated bronze bearings provide excellent wear and low friction characteristics.

5 Pinion Gear and Keyed Output Shaft: Manufactured from high strength steel and precision machined as one piece. The gear/shaft can be easily removed and reinserted to satisfy a variety of keyway orientation requirements.

6 End Caps: Machined from 6061-T6 solid aluminum bar that is anodized for corrosion resistance.

Seal Kits

Bore	Standard Part No.	Low Friction Part No.	Viton® Part No.	Air/Oil Tandem Part No.
1/2"" Single Rack	000SK	000TK	000VK	We recommend that Air/Oil Tandems are returned to the factory for repair.
1/2"" Double Rack	050SK	050TK	050VK	
3/4" Single Rack	100SK	100TK	100VK	
3/4" Double Rack	150SK	150TK	150VK	

Torque Output

Theoretical Torque Output in Inch-pounds (Newton-meters)

Bore Size	Series	PSI (bar)														Inch-pounds per PSI	(Newton-meters per Bar)
		40	(2.8)	60	(4.1)	80	(5.5)	90	(6.2)	100	(6.9)	125	(8.6)	150	(10.3)		
1/2" Single Rack	000	2.0	(.23)	2.9	(.33)	3.9	(.44)	4.4	(.50)	4.9	(.50)	6.1	(.69)	7.4	(.84)	.049	(.080)
1/2" Double Rack	050	4.0	(.45)	5.8	(.66)	7.8	(.88)	8.8	(1.00)	9.8	(1.11)	12.2	(1.38)	14.8	(1.67)	.098	(.160)
3/4" Single Rack	100	6.6	(.75)	9.9	(1.12)	13.3	(1.50)	14.9	(1.68)	16.5	(1.86)	20.7	(2.33)	24.8	(2.80)	.165	(.270)
3/4" Double Rack	150	13.2	(1.49)	19.8	(2.24)	26.6	(3.0)	29.8	(3.37)	33.0	(3.73)	41.4	(4.68)	49.6	(5.60)	.330	(.540)

NOTE: Deduct 10% from torque output for frictional loss. ø3/4" Air/Oil Tandem has the torque output of a Single Rack unit: deduct 20% for frictional loss.

Operating Specifications

Operating Temperature:
-20°F to 200°F (-29°C to 93°C) with Standard Nitrile Seals
-20°F to 400°F (-29°C to 204°C) with Viton® Seals
-20°F to 250°F (-29°C to 121°C) with Low Friction Seals

Operating Pressure:
150 PSI (10 Bar)

Supply:
Filtered compressed air to 150 PSI (10 Bar)

Angle of Rotation:
45°, 90°, 180° Standard
Other rotations available

Rotational Tolerance:
-0° + 1/2°

Backlash Between Rack & Pinion:
2 position units less than 1° of arc maximum
NOTE: For 0° backlash at each end of rotation, specify a double rack actuator with rotation adjustments.

Lubrication:
None required
Norgren Rotary Actuators are rated for "no lube added" service. All internal components are lubricated at the time of assembly with a Teflon® based grease.
Recommended fluid for air/oil tandem is petroleum based hydraulic oil, non-foaming, non-detergent ISO Viscosity grade of 46.

Materials:
End Caps: Black anodized 6061-T6 aluminum
Body: 6061-T6 aluminum alloy, entirely black anodized
Gear Rack: Ground and polished stress proof steel
Pinion Gear and Output Shaft: Manufactured as one piece from high strength steel.
Shaft Bearings: SAE 841 Bronze
Standard Seals: Nitrile

Displacement • Load Bearing Capacity • Unit Weights

Displacement in cubic inches (mm^3); Load Bearing Capacity in pounds force (kilograms); Bearing Distance in inches (mm); Unit Weights in pounds (kilograms)

Bore Size	Displacement for Each Degree of Rotation Inch³	(mm^3)	Axial Load Bearing Capacity lbs	(Kg)	Radial Load Bearing Capacity lbs	(Kg)	Distance Between Bearings Inch	(mm)	Basic Weight-180° Unit lbs	(Kg)	Add for Double Output Shaft lbs	(Kg)
1/2" Single Rack	.0009	(15)	10	(4.54)	25	(11.35)	.66	(17)	.172	(.08)	.031	(.01)
1/2" Double Rack	.0018	(30)	10	(4.54)	25	(11.35)	.66	(17)	1.563	(.71)	.031	(.01)
3/4" Single Rack	.0029	(48)	30	(13.62)	50	(22.70)	.75	(19)	1.344	(.61)	.063	(.03)
3/4" Double Rack	.0058	(95)	30	(13.62)	50	(22.70)	.75	(19)	2.063	(.94)	.063	(.03)

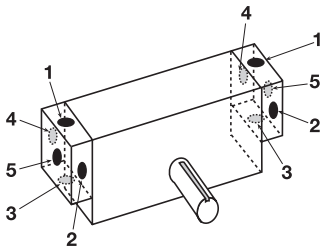
Rotational Velocity

Maximum rotational velocity of a rotary actuator is difficult to determine due to varying factors such as pressure, medium, flow and external loading. Excessive speeds in a given application can create inertia loads whose shock values could prove detrimental to the actuator. Use of external stops, cushions, or other deceleration devices will ensure maximum performance and actuator life. For calculating a moment of inertia, see page 26.

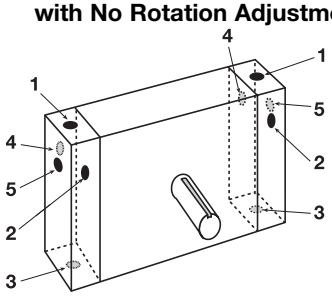
Optional Features:
- **Port Locations**
- **Rotation Adjustment**
- **Viton® Seals for High Temperature**
- **Integral Air/Oil Tandem (3/4" Bore)**
- **Low Friction Seals**
- **Electroless Nickel Plating**
- **Angle Bracket, Front and Rear Flange Mountings**
- **Noise Dampening Bumpers**
- **Double End Output Shaft**

Mini Rotary Actuator Port Locations

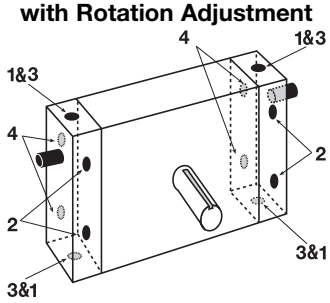
Single Rack



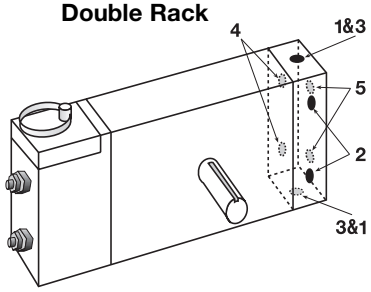
Standard Double Rack with No Rotation Adjustment



Double Rack with Rotation Adjustment



Integral Double Rack



Mini Rotary Integral Air/Oil Tandem (ø3/4" Bore)

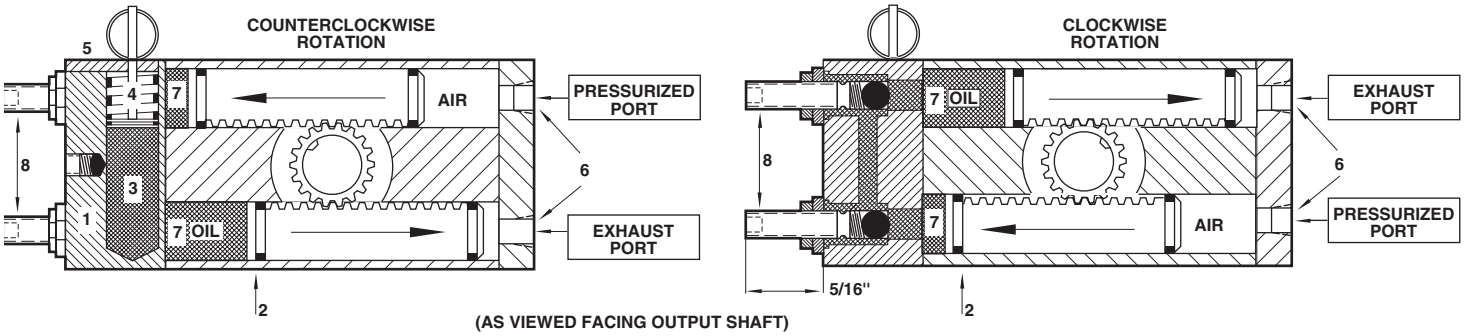
Norgren ø3/4" Bore Mini Rotary Actuator can be supplied with a unique, fully self-contained, air/oil tandem system. This option provides extremely smooth, fully adjustable speed control of the output shaft.

Maximum Speed in degrees per second: (No Load Condition)

	Operating Pressure in PSI (bar)					
Bore Size	40 (2.8)	50 (3.4)	60 (4.1)	70 (4.8)	80 (5.5)	90 (6.2)
3/4"	296°	366°	386°	441°	480°	518°

Note: Theoretical Reservoir Pressure 20 PSI. Oil Temperature 95°F.

Integral Air/Oil Tandem Operating Principle



(AS VIEWED FACING OUTPUT SHAFT)

The **1** **closed loop oil system manifold** including the oil reservoir, is attached to the **2** **actuator body**. This **3** **oil reservoir** allows for the oil fluctuations caused by variations in temperature. A **4** **spring loaded plunger** exerts a constant pressure on the system oil, which keeps the system purged of air. The **5** **ring** attached to the plunger shaft will ***pop up*** when the system oil needs replenishment. When air pressure is applied to **6** **either port**, the gear racks move in opposing directions. **7** **System oil** is displaced from one rack bore to the other by way of the integral **8** **cartridge speed controls** which meter the oil as it passes through the manifold to provide smooth and precise adjustment of the output shaft velocity.

Low Friction Seals

Single and Double Rack Mini Rotary Actuators can be ordered with Low Friction Seals. Nitrile seals, specially compounded with Teflon®, offer extremely smooth low friction operation.
TO ORDER: enter option code **1** or **2** in **Rack/Rotary Type** position **2**.

Electroless Nickel Plating

For corrosive environments, all external components of the actuator are electroless nickel plated or manufactured from 303 stainless steel with the exception of the output shaft. Consult factory for stainless steel output shaft if required. TO ORDER electroless nickel: enter option code **E** in position **13.**

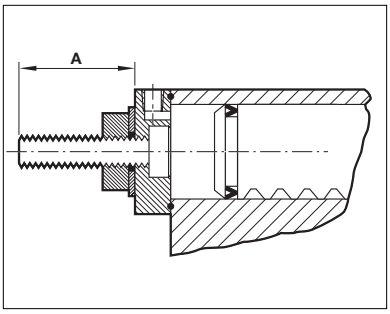
High Temperature Viton® Seals

Viton® Seals are ideal for higher temperature applications -20°F to 400°F (-29°C to 204°C). TO ORDER Viton® seals: enter option code **V** in position **13.**

Rotation Adjustment

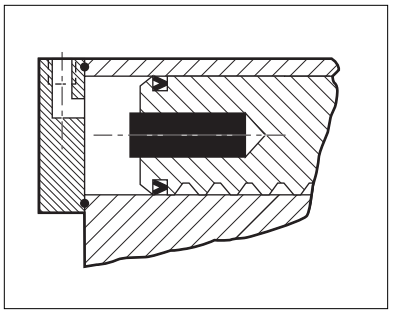
Located in the actuator end cap, each rotation adjustment provides up to 30° of angle reduction.

Bore	1/2"	3/4"
A	.563 (14.29)	.813 (20.64)



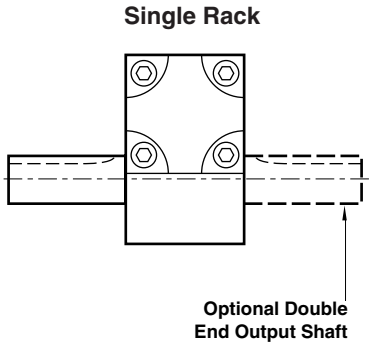
Noise Dampening Bumpers

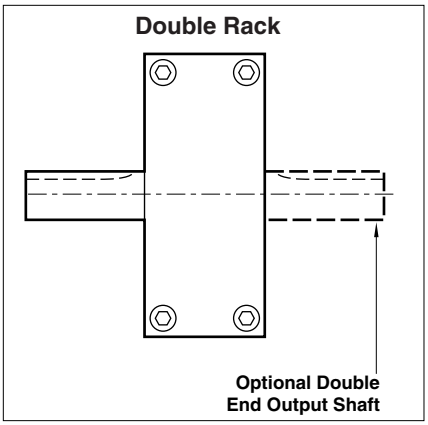
A urethane insert is placed in the gear rack preventing metal to metal contact and providing quiet operation.



Double End Output Shaft

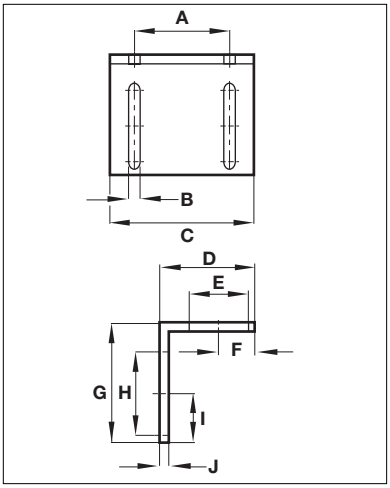
Single and Double Rack Mini Rotary Actuators can be ordered with optional double end keyway output shafts. TO ORDER: enter option code **B** in **Output Shaft** position **5**.





Angle Bracket R-920-100

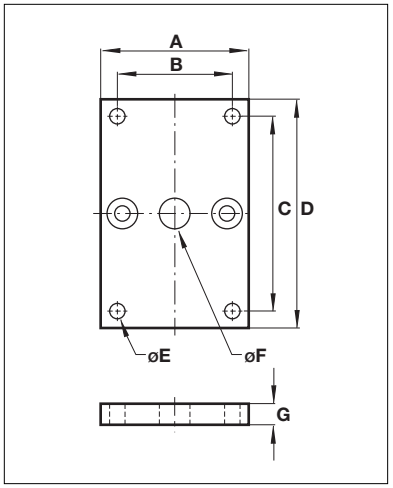
The Angle Bracket can be used to mount any ø1/2" or ø3/4" Mini Rotary Actuator perpendicular to the axis of a Norgren **Series N** twin rod cylinder (Section 4). All brackets include mounting hardware.
TO ORDER: enter option code **5** in **Mounting** position **6**.
NOTE: Mini Rotary Actuators come with standard 1/4" – 28 threads/counterbore for #10 socket head cap screw, machined in the body for direct mounting, if desired.



Bore	1/2"		3/4"	
A	2.00	(51)	2.00	(51)
B	.25	(6)	.25	(6)
C	3.00	(76)	3.00	(76)
D	2.00	(51)	2.00	(51)
E	1.25	(32)	1.25	(32)
F	.75	(19)	.75	(19)
G	2.50	(64)	2.50	(64)
H	1.75	(44)	1.75	(44)
I	1.00	(25)	1.00	(25)
J	.25	(6)	.25	(6)

Front and Rear Flange Mountings R-80-100

Flanges are universal and can be used on both ø1/2" and ø3/4" Mini Rotary Actuators. All flange mounts include mounting hardware. TO ORDER : enter option code **2** or **3** in **Mounting** position **6**.
NOTE: Mini Rotary Actuators come with standard 1/4" – 28 threads/counterbore for #10 socket head cap screw, machined in the body for direct mounting, if desired.

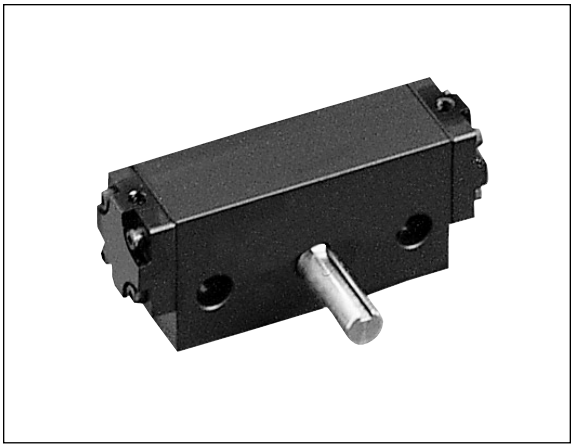


Bore	1/2"		3/4"	
A	2.75	(70)	2.75	(70)
B	2.125	(54)	2.125	(54)
C	3.625	(92)	3.625	(92)
D	4.25	(108)	4.25	(108)
øE	.281	(7)	.281	(7)
øF	.281	(7)	.281	(7)
G	.375	(10)	.375	(10)

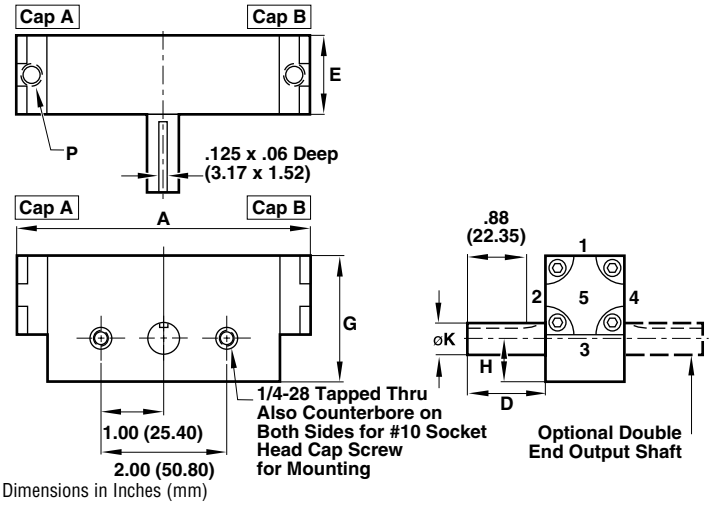
Rack & Pinion Rotary Actuators

Single Rack & Pinion Mini Rotary Actuator (ø1/2" & 3/4" Bores)

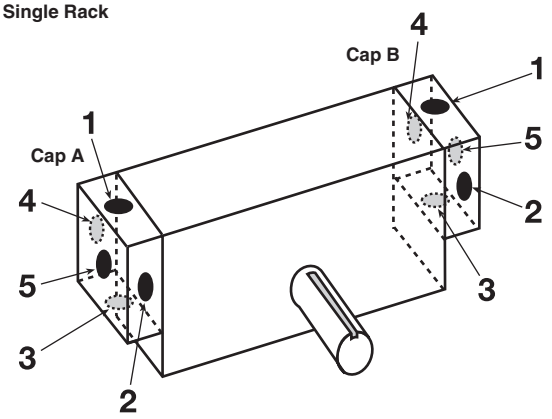
- **Single Rack and Pinion Mini Rotary Actuators are very compact.**
- **Theoretical torque from 2.0 to 24.8 inch-pounds (.23 to 2.80 Newton-meters).**
- **Rotation angles 45°, 90°, and 180° standard.**
- **Nitrile Noise Dampening Bumpers optional.**
- **Viton® Seals optional for higher temperatures.**
- **Optional Low Friction Seals.**
- **Body Mount or optional Angle Bracket, Front and Rear Flange Mountings.**



Basic Dimensions Single Rack and Pinion Mini Rotary Actuator



Port Positions
Single Rack



All Dimensions in Inches (mm)

Bore	A	D	E	G	H	øK	P
1/2" Single Rack and Pinion	3.50 (89)	1.06 (27)	1.00 (25)	1.50 (38)	.59 (15)	.375 (9.53)	10-32
3/4" Single Rack and Pinion	4.88 (124)	1.25 (32)	1.25 (32)	2.00 (51)	.69 (18)	.500 (12.70)	1/8 NPT

Single Rack and Pinion Mini Rotary Actuator Order Information

■	■	0	■	■	–	■	■	A	–	A	■	■	0	■
1	2	3	4	5		6	7	8		9	10	11	12	13

Bore

0	1/2"
1	3/4"

Rack/Rotary Type

0	Single Rack Standard Seals
1	Single Rack Low Friction Seals

Multiple Position

0	N/A

Rotation

A	45°
B	90°
C	180°
X	Special

Output Shaft

A	Single End Keyway Standard
B	Double End Keyway
X	Special

Mounting

1	Standard
2	Front Flange
3	Rear Flange
5	Angle Bracket
X	Special

Port & Location

A	Port Position 1*
B	Port Position 2
C	Port Position 3
D	Port Position 4
F	Port Position 5

*Standard Port Location

Cushions

A	N/A

Flow Controls

A	N/A

Bumper

A	No Bumpers
B	End Cap A
C	End Cap B
D	All Caps

Switches

0	N/A

Rotation Adjustments

1	No Adjustment
2	End Cap A
3	End Cap B
4	End Caps A & B
X	Special

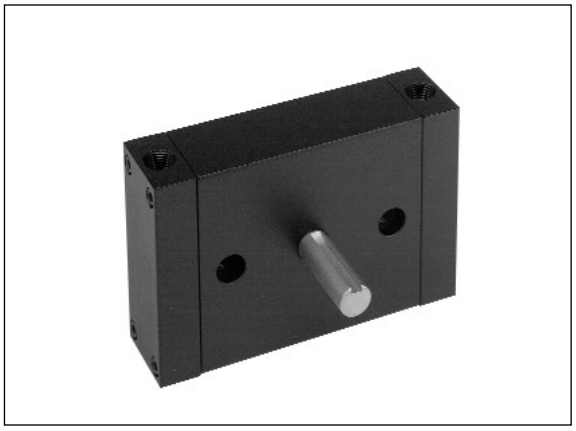
Options

0	No Option
E	Electroless Nickel
V	Viton® Seals
X	Special (Specify)

See ACT-12-9 for complete instructions on how to order Mini Rotary Actuators.

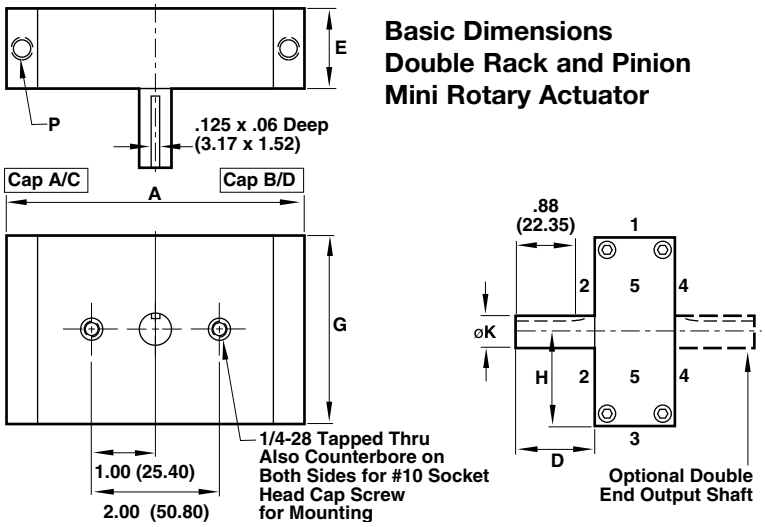
Rack & Pinion Rotary Actuators

Double Rack & Pinion
Mini Rotary Actuator (ø1/2" & 3/4" Bores)



- **Double Rack and Pinion Mini Rotary Actuators have double the theoretical torque of a Single Rack Rotary.**
- **Theoretical torque from 4.0 to 49.6 inch-pounds (.45 to 5.60 Newton-meters).**
- **Rotation angles 45°, 90°, and 180° standard.**
- **Nitrile Noise Dampening Bumpers optional.**
- **Viton® Seals optional for higher temperatures.**
- **Optional Low Friction Seals.**
- **Body Mount or optional Angle Bracket, Front and Rear Flange Mountings.**

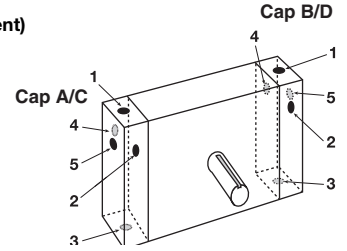
Basic Dimensions
Double Rack and Pinion
Mini Rotary Actuator



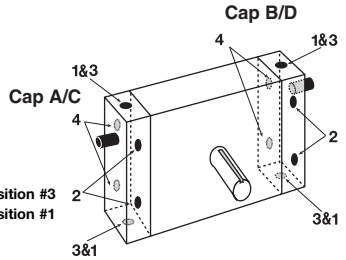
All Dimensions in Inches (mm)

Bore	A	D	E	G	H	øK	P
1/2" Double Rack and Pinion	3.75 (95)	1.06 (27)	1.00 (25)	2.50 (64)	1.25 (32)	.375 (9.53)	1/8 NPT
3/4" Double Rack and Pinion	4.75 (121)	1.25 (32)	1.25 (32)	3.00 (76)	1.50 (38)	.500 (12.70)	1/8 NPT

Port Positions for Double Rack (No Rotation Adjustment)



Port Positions for Double Rack with Rotation Adjustment



NOTE: With Rotation Adjustment,
Port Position #1 includes Port Position #3
Port Position #3 includes Port Position #1

Double Rack and Pinion Mini Rotary Actuator Order Information

■ ■ 0 ■ ■ – ■ ■ A – A ■ ■ 0 ■

1 2 3 4 5 6 7 8 9 10 11 12 13

Bore	
0	1/2"
1	3/4"

Rack/Rotary Type	
2	Double Rack Low Friction Seals
5	Double Rack Standard Seals

Multiple Position	
0	N/A

Rotation	
A	45°
B	90°
C	180°
X	Special

Output Shaft	
A	Single End Keyway Standard
B	Double End Keyway
X	Special

Mounting	
1	Standard
2	Front Flange
3	Rear Flange
5	Angle Bracket
X	Special

Port & Location	
A	Port Position 1*
B	Port Position 2
C	Port Position 3
D	Port Position 4
F	Port Position 5

*Standard Port Location
NOTE: Port Position 5 is not available with Rotation Adjustment

Cushions	
A	N/A

Flow Controls	
A	N/A

Bumper	
A	No Bumpers
B	End Cap A
C	End Cap B
D	All Caps

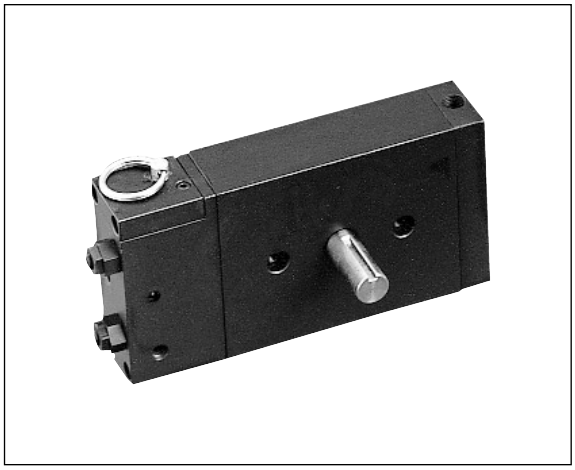
Switches	
0	N/A

Rotation Adjustments	
1	No Adjustment
2	End Cap A
3	End Cap B
4	End Caps A & B
5	End Caps B & D
X	Special

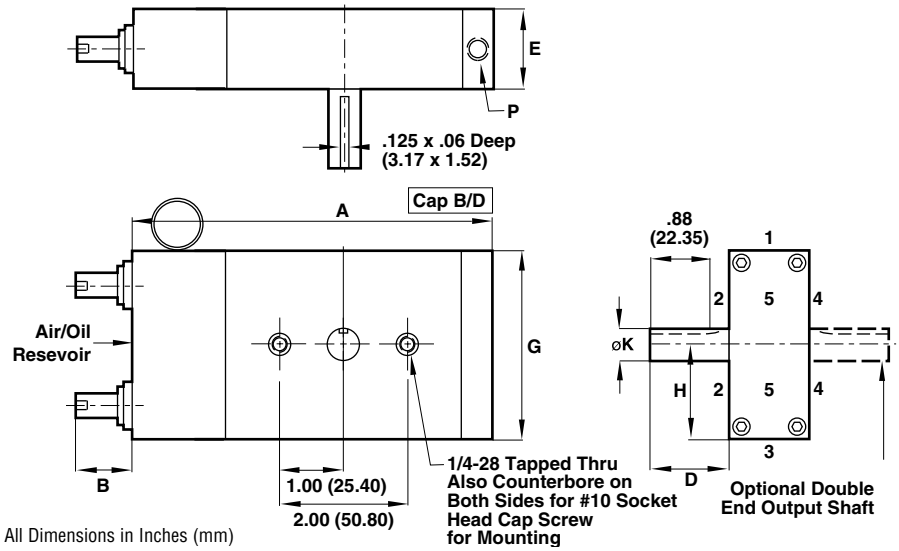
Options	
0	No Option
E	Electroless Nickel
V	Viton® Seals
X	Special (Specify)

See ACT-12-9 for complete instructions on how to order Mini Rotary Actuators.

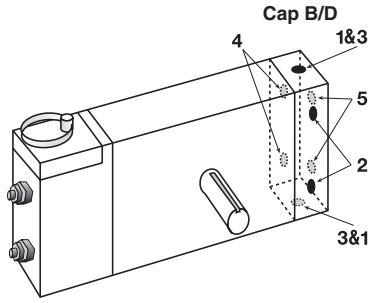
- **Integral Air/Oil Tandem Double Rack and Pinion Mini Rotary Actuators have the same theoretical torque of Single Rack Rotaries.**
- **Theoretical torque from 2.0 to 24.8 inch-pounds (.23 to 2.80 Newton-meters).**
- **Rotation angles 45°, 90°, and 180° standard.**
- **Nitrile Noise Dampening Bumpers optional.**
- **Viton® Seals optional for higher temperatures.**
- **Body Mount or optional Angle Bracket, Front and Rear Flange Mountings.**



Basic Dimensions Double Rack and Pinion Mini Rotary Actuator with Integral Air-Oil Tandem



Standard Port Positions
Integral Air/Oil Tandem
Double Rack



NOTE: Port Position #1 Includes Port Position #3

All Dimensions in Inches (mm)

Bore	A	B	D	E	G	H	øK	P
3/4" Double Rack with Air/Oil Tandem	5.75 (121)	.3125 (8)	1.25 (32)	1.25 (32)	3.00 (76)	1.50 (38)	.500 (12.70)	1/8 NPT

Integral Air/Oil Tandem Double Rack and Pinion Mini Rotary Actuator Order Information

1	7	0	■	■	–	■	■	A	–	A	■	■	0	■
1	2	3	4	5		6	7	8		9	10	11	12	13

Bore	
1	3/4"

Rack/Rotary Type	
7	Double Rack Integral A/O Tandem Standard Seals

Multiple Position	
0	N/A

Rotation	
A	45°
B	90°
C	180°
X	Special

Output Shaft	
A	Single End Keyway Standard
B	Double End Keyway
X	Special

Mounting	
1	Standard
2	Front Flange
3	Rear Flange
5	Angle Bracket
X	Special

Port & Location	
A	Port Position 1 and 3*
B	Port Position 2
D	Port Position 4
F	Port Position 5

*Standard Port Locations are Postions 1 and 3.

Cushions	
A	N/A

Flow Controls	
A	N/A

NOTE: Flow Controls are standard on end caps A & C.

Bumper	
A	No Bumpers
B	End Cap A
C	End Cap B
D	All Caps

Switches	
0	N/A

Rotation Adjustments	
1	No Adjustment
2	N/A
3	End Cap B
4	N/A
5	End Caps B & D
X	Special

Options	
0	No Option
E	Electroless Nickel
V	Viton® Seals
X	Special (Specify)

See ACT-12-9 for complete instructions on how to order Mini Rotary Actuators.

Mini Rotary Actuator Order Information

1	7	0	C	B	–	2	B	A	–	A	A	5	0	V
1	2	3	4	5		6	7	8		9	10	11	12	13

Bore	
0	1/2"
1	**3/4"**

Rack/Rotary Type	
0	Single Rack Standard Seals
1	Single Rack Low Friction Seals
2	Double Rack Low Friction Seals
5	Double Rack Standard Seals
7	**Double Rack Integral A/O Tandem Standard Seals (ø 3/4" Bore only in mini rotary)**

Multiple Position Actuator	
0	**2 Position**
X	Special

Rotation	
A	45°
B	90°
C	**180°**
X	Special

Output Shaft	
A	Single End Keyway Standard
B	**Double End Keyway**
X	Special

Mounting	
1	Standard
2	**Front Flange**
3	Rear Flange
5	Angle Bracket
X	Special

Cushions	
A	N/A

Flow Controls	
A	N/A

Port & Location	
A	Port Position 1*
B	**Port Position 2**
C	Port Position 3
D	Port Position 4
F	Port Position 5

*Standard Port Location

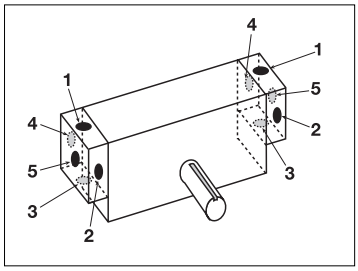
Bumper	
A	**No Bumpers**
B	End Cap A
C	End Cap B
D	All Caps

Switches	
0	N/A

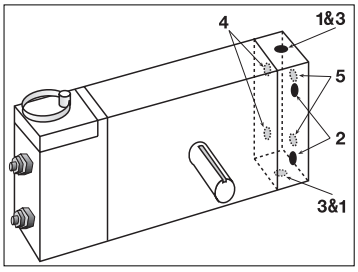
Rotation Adjustments	
1	No Adjustment
2	End Cap A
3	End Cap B
4	End Caps A & B
5	**End Caps B & D**
X	Special

Options	
0	No Option
E	Electroless Nickel
V	**Viton® Seals**
X	Special (Specify)

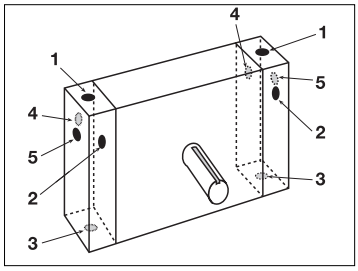
Port Positions Single Rack



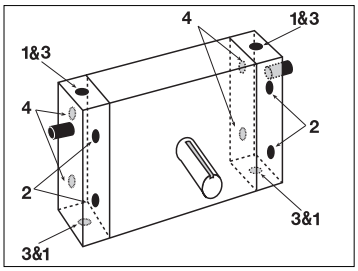
Port Positions Integral Double Rack



Port Positions Double Rack without Rotation Adjustment

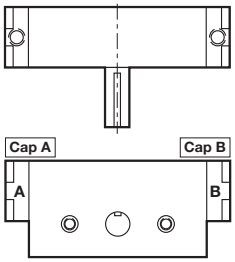


Port Positions Double Rack with Rotation Adjustment

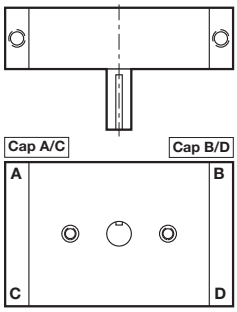


EXAMPLE: Mini Rotary Actuator 3/4" Bore – Double Rack Integral Air/Oil Tandem Mini Rotary Actuator – 2 Position – 180° Rotation – Double End Keyway Output Shaft – Front Flange Mounting – Port Position 2 – No Bumpers – Rotation Adjustment End Caps B & D – Viton® Seals.

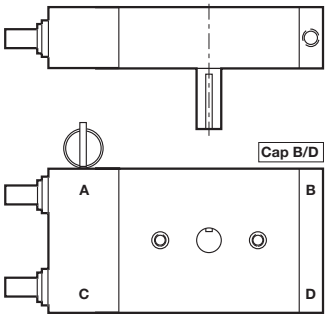
Single Rack



Double Rack



Integral Air/Oil Tandem Double Rack



Rotary Actuators are constructed with the finest materials for each component!

1 Floating Pistons: Solid aluminum alloy, lightweight for low inertia, yet strong. Provide excellent wear characteristics against the hard coated tube I.D.

2 Seals: Lip type, pressure sensitive nitrile seals are wear compensating for long service life and minimum friction.

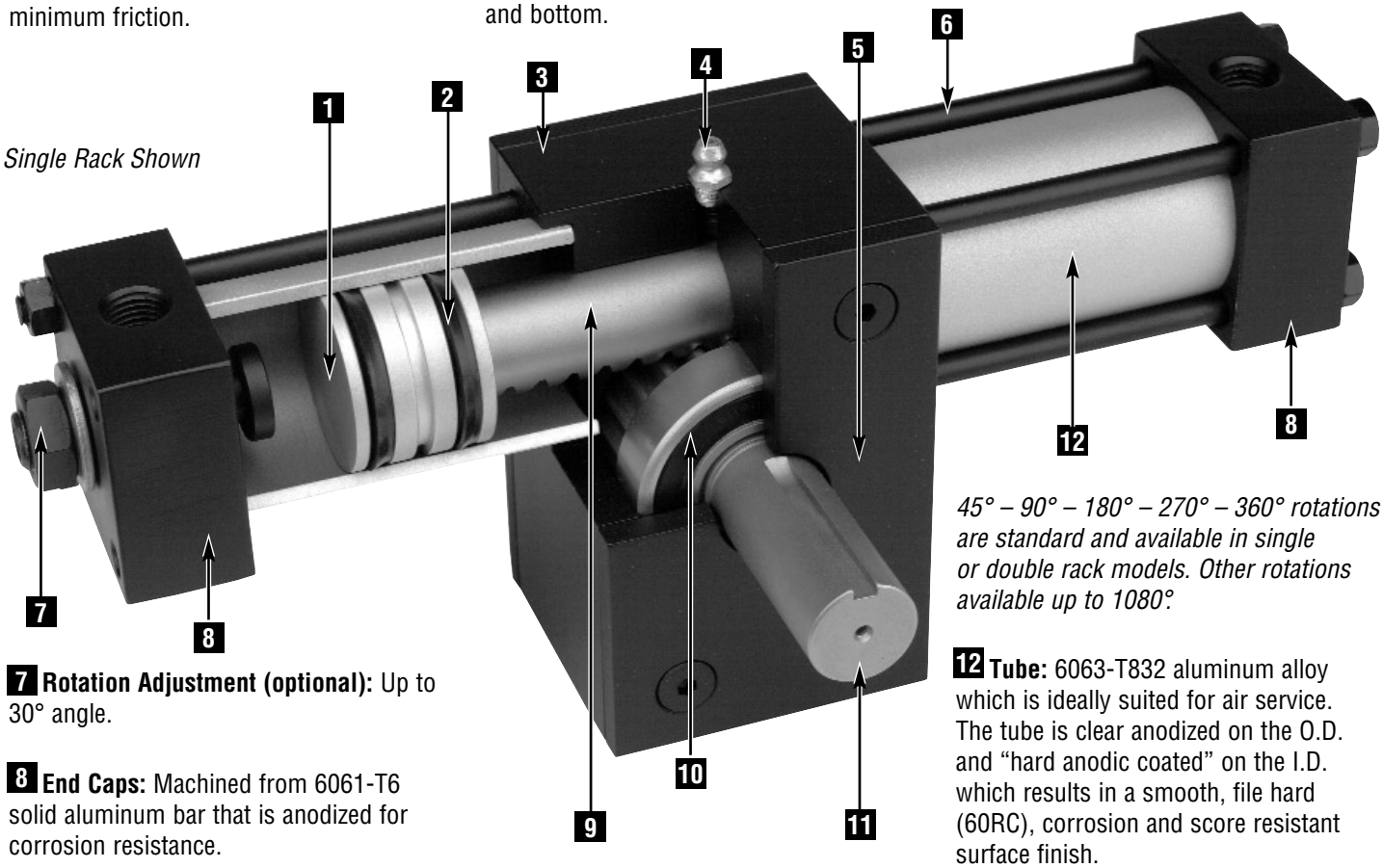
3 Actuator Body: Precision machined from 6061-T6, 40,000 PSI minimum yield aluminum alloy for strength. The entire body is then hard-anodized for maximum wear and corrosion resistance.

4 Grease Fitting: Easy access for additional lubrication. Single rack located on top; double located on top and bottom.

5 Retainers: Aluminum plates are located on the front and rear of the actuator body to ensure positive retention of the pinion/shaft/bearing assembly.

6 Tie Rods: Stress-proof steel to maintain compression on the tube end seals.

Single Rack Shown



45° – 90° – 180° – 270° – 360° rotations are standard and available in single or double rack models. Other rotations available up to 1080°.

7 Rotation Adjustment (optional): Up to 30° angle.

8 End Caps: Machined from 6061-T6 solid aluminum bar that is anodized for corrosion resistance.

9 Rack: Ground and polished stress-proof steel.

10 Shaft Bearings: Sealed, single row ball bearings provide exceptional shaft stability with a low coefficient of friction.

11 Pinion and Output Shaft: Manufactured from high strength steel for maximum strength and endurance. A keyed output shaft is standard with other shaft options available.

12 Tube: 6063-T832 aluminum alloy which is ideally suited for air service. The tube is clear anodized on the O.D. and "hard anodic coated" on the I.D. which results in a smooth, file hard (60RC), corrosion and score resistant surface finish.

Options not shown: Low Friction Seals, Cartridge Speed Controls,High Temperature Viton® Seals, Adjustable Cushions, Bumpers, Magnetic Piston for Position Sensing, Multi-Position Rotation Capabilities.

Seal Kits

Bore	Standard Part No.	Low Friction Part No.	Viton® Part No.	Air/Oil Tandem Part No.
1 1/8" Single Rack	200SK	200TK	200VK	We recommend that Air/Oil Tandems are returned to the factory for repair.
1 1/8" Double Rack	250SK	250TK	250VK	
1 1/2" Single Rack	300SK	300TK	300VK	
1 1/2" Double Rack	350SK	350TK	350VK	
2" Single Rack	400SK	400TK	400VK	
2" Double Rack	450SK	450TK	450VK	
2 1/2" Single Rack	500SK	500TK	500VK	
2 1/2" Double Rack	550SK	550TK	550VK	

Rotational Velocity

Maximum rotational velocity of a rotary actuator is difficult to determine due to varying factors such as pressure, medium, flow and external loading. Excessive speeds in a given application can create inertia loads whose shock values could prove detrimental to the actuator. Use of external stops, cushions, or other deceleration devices will ensure maximum performance and actuator life.

Operating Specifications

Operating Temperature:

-20° to 200°F (-29°C to 93°C) with Standard Nitrile Seals
-20° to 400°F (-29°C to 204°C) with Viton® Seals
-20° to 250°F (-29°C to 121°C) with Low Friction Seals

Operating Pressure:

150 PSI (10 Bar)
400 PSI (27.6 Bar) Hydraulic (non-shock)

Supply:

Filtered compressed air to 150 PSI
Petroleum based hydraulic fluid to 400 PSI

Angle of Rotation:

45°, 90°, 180°, 270°, 360° Standard
Any rotation up to 1080° can be supplied

Rotational Tolerance:

-0° + 10°

Backlash Between Rack & Pinion:

1 1/8" Bore 2 position units 1° of arc maximum
1 1/2" – 2 1/2" Bore 2 position units 30 minutes of arc maximum

Lubrication:

None required
Norgren Rotary Actuators are rated for "no lube added" service. All internal components are lubricated at the time of assembly with a Teflon® based grease. Should additional lubrication become necessary between the radial surface of the rack gear and the rack/pinion mesh area due to severe operating conditions, a grease fitting is provided.

Materials:

End Caps: Black anodized 6061-T6 aluminum
Body: 6061-T6 aluminum alloy, entirely hard coat anodized
Gear Rack: Ground and polished stress-proof steel
Pinion Gear and Output Shaft: Manufactured from high-strength steel.
Shaft Bearings: Sealed, single row ball bearings
Standard Seals: Nitrile
Tube: 6063-T832 aluminum alloy
Tie Rods: Stress-proof steel
Floating Pistons: Solid aluminum alloy

Displacement • Load Bearing Capacity • Unit Weights

Displacement in cubic inches (mm^3); Load Bearing Capacity in pounds force (kilograms); Bearing Distance in inches (mm); Unit Weights in pounds (kilograms)

Bore Size	Displacement for Each Degree of Rotation Inch³	(mm^3)	Axial Load Bearing Capacity lbs	(Kg)	Radial Load Bearing Capacity lbs	(Kg)	Distance Between Bearings Inch	(mm)	Unit Weight 90° lbs	(Kg)	Unit Weight 180° lbs	(Kg)	Unit Weight 360° lbs	(Kg)	Add for Double Output Shaft lbs	(Kg)
1 1/8" Single Rack	.0108	(177)	100	(45)	200	(91)	1.38	(35)	3.5	(1.59)	3.75	(1.70)	4.25	(1.93)	.063	(.03)
1 1/8" Double Rack	.0216	(354)	100	(45)	200	(91)	1.38	(35)	6	(2.72)	7	(3.18)	8.5	(3.86)	.063	(.03)
1 1/2" Single Rack	.0270	(443)	225	(102)	450	(204)	1.56	(40)	6.75	(3.06)	7.5	(3.41)	9	(4.09)	.344	(.16)
1 1/2" Double Rack	.0540	(885)	225	(102)	450	(204)	1.56	(40)	10.5	(4.77)	12.75	(5.79)	17.25	(7.83)	.344	(.16)
2" Single Rack	.0760	(1254)	500	(227)	1000	(454)	2.28	(58)	18	(8.17)	19.5	(8.85)	21	(9.53)	.656	(.30)
2" Double Rack	.1520	(2491)	500	(227)	1000	(454)	2.28	(58)	22	(9.98)	24	(10.90)	27	(12.26)	.656	(.30)
2 1/2" Single Rack	.1200	(1966)	500	(227)	1000	(454)	2.28	(58)	18.5	(8.40)	20	(9.08)	22	(9.99)	.656	(.30)
2 1/2" Double Rack	.2400	(3933)	500	(227)	1000	(454)	2.28	(58)	22.5	(10.22)	24.5	(11.12)	27.5	(12.49)	.656	(.30)

Torque Output

Theoretical Torque Output in Inch-pounds per PSI (Newton-meters per Bar)

Bore Size	PSI (Bar) 40	(2.8)	60	(4.1)	80	(5.5)	90	(6.2)	100	(6.9)	125	(8.6)	150	(10.3)	200	(13.8)	250	(17.2)	400	(27.6)	Inch-pounds per PSI	(Newton-meters per Bar)
1 1/8" Single Rack	25	(2.8)	37	(4.2)	50	(5.6)	56	(6.3)	62	(7.0)	78	(8.8)	93	(17.5)	124	(10.5)	156	(17.6)	249	(28.1)	.6	(.59)
1 1/8" Double Rack	50	(5.6)	75	(8.4)	100	(11.3)	112	(12.7)	124	(14.1)	155	(17.6)	187	(21.1)	249	(28.1)	311	(35.1)	498	(56.2)	1.2	(1.97)
1 1/2" Single Rack	62	(7.0)	93	(10.4)	124	(14.0)	139	(15.7)	155	(17.5)	194	(21.9)	232	(26.2)	310	(35.0)	387	(43.7)	620	(70.0)	1.6	(2.62)
1 1/2" Double Rack	124	(14.0)	186	(21.0)	248	(28.0)	279	(31.5)	310	(35.0)	387	(43.8)	465	(52.5)	620	(70.0)	774	(87.5)	1239	(140.0)	3.2	(5.24)
2" Single Rack	175	(19.9)	264	(29.8)	352	(39.7)	396	(44.7)	440	(49.7)	550	(62.1)	660	(74.4)	879	(99.3)	1099	(124.1)	1758	(198.6)	4.4	(7.21)
2" Double Rack	352	(39.7)	528	(59.6)	703	(79.5)	791	(89.4)	879	(99.3)	1099	(124.1)	1319	(149.0)	1758	(198.6)	2198	(248.3)	3517	(397.2)	8.8	(14.41)
2 1/2" Single Rack	275	(31.0)	412	(46.6)	550	(62.1)	619	(69.9)	687	(77.7)	860	(97.1)	1031	(116.5)	1375	(155.3)	1719	(194.1)	2750	(310.6)	6.9	(11.30)
2 1/2" Double Rack	550	(62.1)	825	(93.2)	1100	(124.2)	1237	(139.8)	1375	(155.3)	1719	(194.1)	2062	(232.9)	2750	(310.6)	3437	(388.2)	5500	(621.2)	13.8	(22.60)

NOTE: Air/Oil Tandem and Multiple Position Rotary Actuators utilize a double rack configuration; however, the torque output of a **Single Rack** unit apply. Deduct 10% from torque output for frictional loss. Deduct 20% for frictional loss on all Air/Oil Tandem Rotary Actuators.

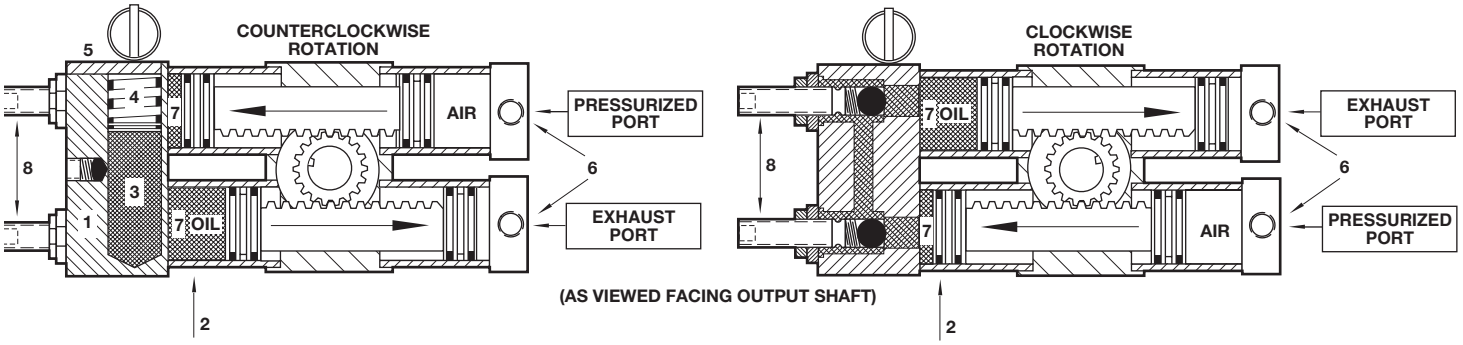
Optional Features:

- **Integral Air/Oil Tandem**
- **Rotation Adjustment**
- **Viton® Seals for High Temperature**
- **Cartridge Speed Control**
- **Low Friction Seals**
- **Electroless Nickel Plating**
- **Front, Rear & Bottom Mount Flanges**
- **Noise Dampening Bumpers**
- **Double End Output Shaft**
- **Switches**
- **Adjustable Cushion**

Integral Air/Oil Tandem

Norgren Rotary Actuators can be supplied with a unique, fully self-contained, air-oil tandem system. This option provides extremely smooth, fully adjustable speed control of the output shaft. . . the simplicity of compressed air with the smooth control of hydraulics!

Integral Air/Oil Tandem Operating Principle



The **1** **closed loop oil system manifold**, including oil reservoir is attached with tie rods to the **2** **actuator unit**. This **3** **oil reservoir** allows for the oil fluctuations caused by variations in temperature. A **4** **spring loaded plunger** exerts a constant pressure on the system oil, which keeps the system purged of air. The **5** **ring** attached to the plunger shaft will ***pop up*** when the system oil needs replenishment. When air pressure is applied to **6** **either port**, the gear racks move in opposing directions. **7** **System oil** is displaced from one rack bore to the other by way of the integral **8** **cartridge speed controls** which meter the oil as it passes through the manifold to provide smooth and precise adjustment of the output shaft velocity.

Maximum Speed in degrees per second: No Load Condition

	Operating Pressure in PSI (bar)					
Bore Size	**40 (2.8)**	**50 (3.4)**	**60 (4.1)**	**70 (4.8)**	**80 (5.5)**	**90 (6.2)**
1 1/8"	254°	284°	309°	353°	384°	415°
1 1/2"	242°	271°	302°	340°	365°	382°
2"	197°	222°	251°	282°	303°	315°
2 1/2"	152°	173°	199°	233°	240°	248°

NOTE: Theoretical Reservoir Pressure 20 PSI. Oil Temperature 95°F.

Low Friction Seals

Single and Double Rack Rotary Actuators can be ordered with Low Friction Seals. Nitrile seals, specially compounded with Teflon®, offer extremely smooth low friction operation. TO ORDER: enter option code **1** or **2** in **Rack/Rotary Type** position **2**.

Electroless Nickel Plating

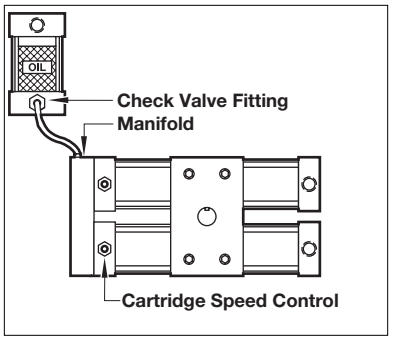
All external components of the actuator are electroless nickel plated or manufactured from 303 stainless steel with the exception of the output shaft for corrosive environments. Consult factory for stainless steel output shaft if required. TO ORDER electroless nickel: enter option code **E** in **Rack/Rotary Type** position **13**.

High Temperature Viton® Seals

Viton® Seals are ideal for higher temperature applications -20°F to 400°F (-29°C to 204°C). TO ORDER Viton® seals: enter option code **V** in **Rack/Rotary Type** position **13**.

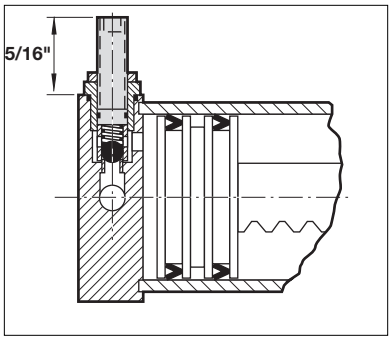
Standard Air/Oil Tandem

Rotary unit is supplied with an Air/Oil Tank that requires a 20 PSI pressure header.
TO ORDER: enter option code **6** in **Rack/Rotary Type** position **2**.



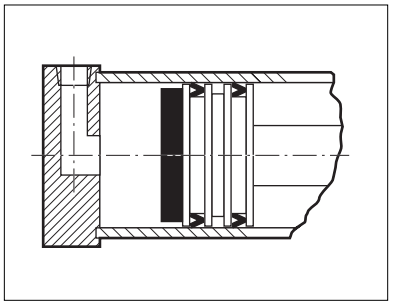
Cartridge Speed Control

ø1 1/2" thru ø2 1/2"
Bores only.
NOTE: Cartridge Speed Control & Cushion are ***not*** available on same end cap.



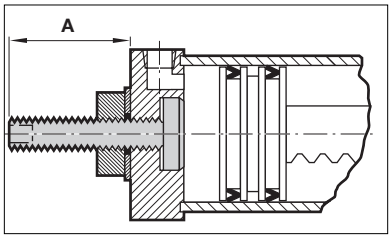
Noise Dampening Bumper

Urethane bumpers attached to the actuator piston provides quiet operation by preventing metal to metal contact.
NOTE: Each bumper adds 1/4" to **A** dimension.



Rotation Adjustment

Located in the actuator end cap, each rotation adjustment provides up to 30° of angle reduction.
NOTE: Cushion & Rotation Adjustment are ***not*** available on the same end cap.

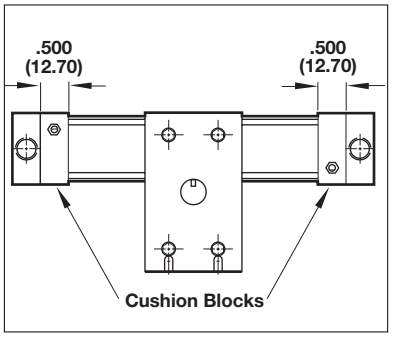


Bore	1 1/8"	1 1/2"	2"	2 1/2"
A	.687 (17.46)	.938 (23.81)	1.187 (30.16)	1.187 (30.16)

Cushioning

The Cushioning Principle

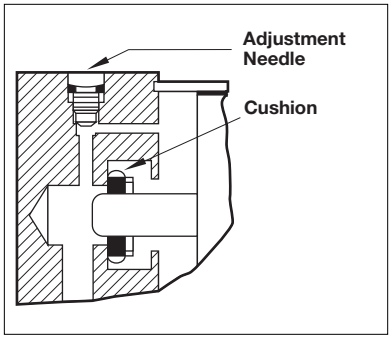
Cushions permit the trapping of cylinder exhaust volume prior to the completion of full rotation. This volume is then metered through a finely tapered needle to deliver smooth, adjustable deceleration of the rotary actuator. NOTE: On 1 1/8" bores, add 1/2" to overall dimension for each cushion block.



Cushion Design 1 1/8" Bore

Adjustable Cushioning

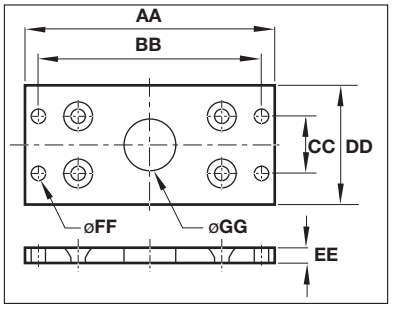
Flush, self locking adjustment needle allows fine cushion metering. Cushion design features a unique, one piece, nitrile compound seal captured within a groove machined to exacting tolerances. This allows linear and radial ***float*** of the cushion seal, virtually eliminating problems associated with misalignment. The design also provides exceptionally fast ***out of cushion*** rotation reversal.



Cushion Design 1 1/2" or 2 1/2" Bore

Front and Rear Mounting Flanges

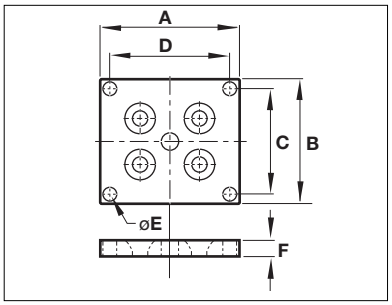
TO ORDER: enter option code **2** or **3** in **Rack/Rotary Type** position **6**.



Bore	1 1/8"		1 1/2"		2"		2 1/2"	
Series	200 – 250		300 – 350		400 – 450		500 – 550	
Part	R-80-225K		R-80-03K		R-80-04K		R-80-04K	
AA	4.812	(122)	5.875	(149)	8.625	(219)	8.625	(219)
BB	4.062	(103)	5.125	(130)	7.625	(194)	7.625	(194)
CC	1.500	(38)	1.500	(38)	2.000	(51)	2.000	(51)
DD	2.250	(57)	2.750	(70)	4.000	(102)	4.000	(102)
EE	.250	(6)	.375	(10)	.437	(11)	.437	(11)
øFF	.343	(9)	.343	(9)	.531	(13)	.531	(13)
øGG	.562	(14)	.937	(24)	1.312	(33)	1.312	(33)

Bottom Mounting Flanges

TO ORDER: enter option code **4** in **Rack/Rotary Type** position **6**.

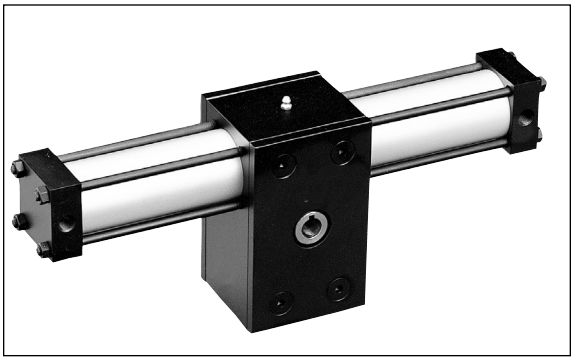


Bore	1 1/8"		1 1/2"		2"		2 1/2"	
Series	200 – 250		300 – 350		400 – 450		500 – 550	
Part	R-942-225K		R-942-03K		R-942-04K		R-942-04K	
A	4.250	(108)	5.000	(127)	5.000	(127)	5.000	(127)
B	2.250	(57)	3.000	(76)	4.000	(102)	4.000	(102)
C	1.625	(41)	2.375	(60)	3.375	(86)	3.375	(86)
D	3.625	(92)	4.375	(111)	4.375	(111)	4.375	(111)
øE	.281	(7)	.406	(10)	.406	(10)	.406	(10)
F	.375	(10)	.437	(11)	.437	(11)	.437	(11)

Rack & Pinion Rotary Actuators

Single Rack & Pinion Rotary Actuator (ø1 1/8" to 2 1/2" Bores)

- **Single Rack and Pinion Rotary Actuators are designed for non-lube added service.**
- **Theoretical torque from 25 to 2750 inch-pounds (2.82 to 310.63 Newton-meters).**
- **Rotation angles 45°, 90°, 180°, 270° and 360° standard.**
- **Urethane Noise Dampening Bumpers optional.**
- **Viton® Seals optional for higher temperatures.**
- **Body Mount or optional Bottom, Front and Rear Flange Mountings.**



Single Rack and Pinion Rotary Actuator Order Information

■ ■ ■ ■ ■ – ■ ■ ■ – ■ ■ ■ ■ ■

1 2 3 4 5 6 7 8 9 10 11 12 13

Bore	
2	1 1/8"
3	1 1/2"
4	2"
5	2 1/2"

Rack/Rotary Type	
0	Single Rack Standard Seals
1	Single Rack Low Friction Seals
X	Special

Multiple Position Actuator	
0	N/A

Rotation	
A	45°
B	90°
C	180°
D	270°
E	360°
X	Special

Output Shaft	
A	Single End Keyway Standard
B	Double End Keyway
C	Hollow Internal Keyway
D	Cross Keyway
E	Preloaded Keyway
X	Special

Mounting	
1	Standard
2	Front Flange
3	Rear Flange
4	Bottom Flange
X	Special

Port Size & Location					
Position	1	2	3	4	5
Standard	A	B*	C	D	F
Oversized	E	G	H	J	K
Special	X				

*Standard Port Size and Location.

Options	
0	No Option
E	Electroless Nickel
P	Loaded Piston Seals
V	Viton® Seals
X	Special (Specify)

Magnetic Option	
0	No Magnet
M	Standard Magnetic Piston in Position A & B

NOTE: See ACT-12-21 for information on switches.

Rotation Adjustments	
1	No Adjustment
2	End Cap A
3	End Cap B
4	End Caps A & B
X	Special

NOTE: Standard rotation adjustments provide 30° of angle reduction.

Bumper	
A	No Bumpers
B	End Cap A
C	End Cap B
D	All Caps
X	Special

Flow Controls				
Needle Position	1	2	3	4
No Flow Controls	A			
End Cap A	B	C	D	E
End Cap B	G	H	J	K
End Caps A & B	M	N	P	R
Special	X			

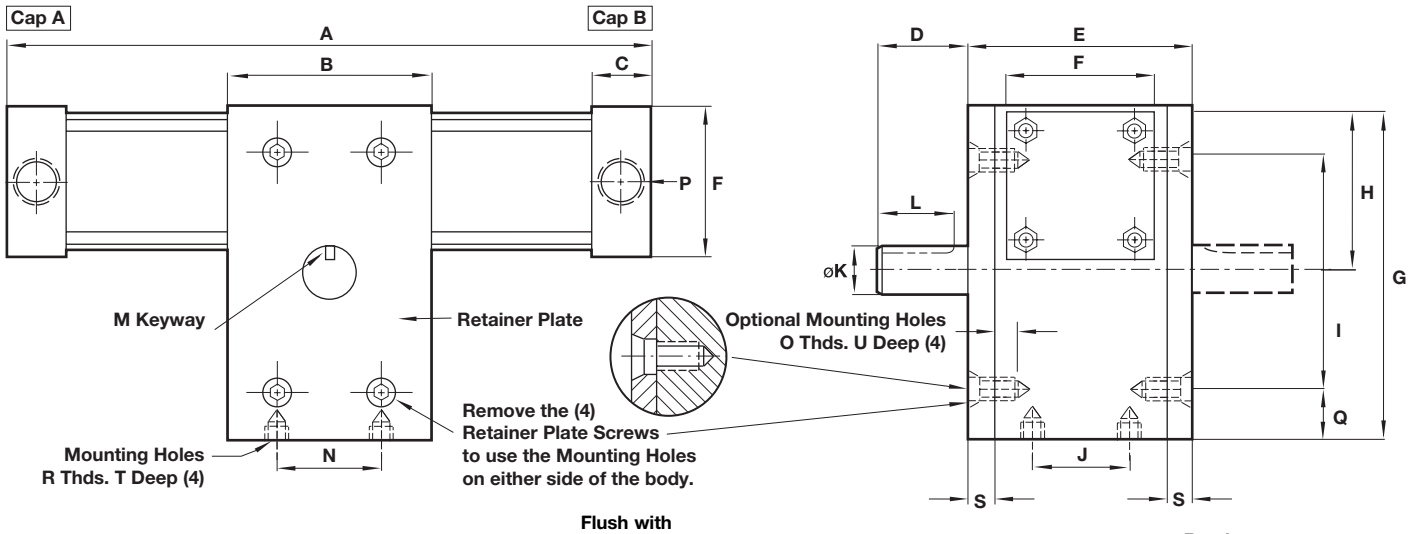
NOTE: Flow Controls must be 90° to Port Location. Flow controls are Standard on all Air/ Oil Tandems. Standard Air/ Oil Tandem Flow Controls are in end caps A & C in position #2. Integral Air/ Oil Tandem Flow Controls are in position #5.

Cushions				
Needle Position	1	2	3	4
No Cushions	A			
End Cap A	B	C	D	E
End Cap B	G	H	J	K
End Caps A & B	N	M	P	R
Special	X			

NOTE: Cushions & Rotation Adjustment cannot be located in same end cap.

See ACT-12-20 for complete instructions on how to order Mini Rotary Actuators.

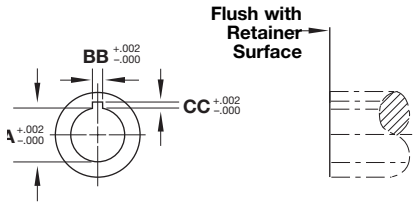
Basic Dimensions Single Rack and Pinion Rotary Actuator



Shaft Options

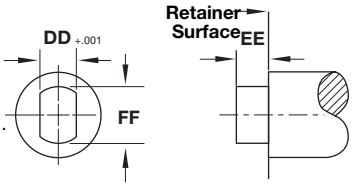
Internal Keyed Hollow

Shaft can be utilized from either side and is flush with retaining plates.
2" bore – 1.00" (25.4) hollow-optional
2½" bore – .688" (17.48) hollow-optional



Cross Keyed

Shaft protrudes from retainer EE dimension.

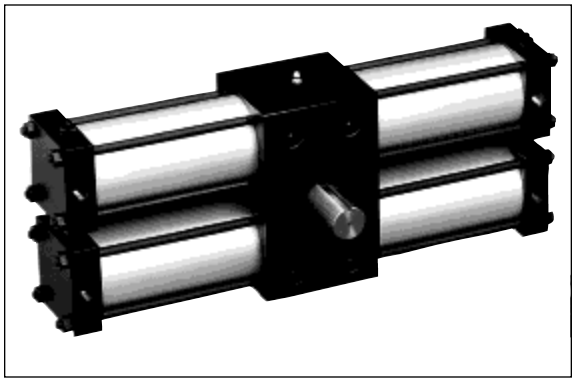


Dimension	Degree Rotation	1⅛" Bore Single Rack		1½" Bore Single Rack		2" Bore Single Rack		2½" Bore Single Rack	
A	0°	4.500	(114)	6.500	(165)	7.750	(197)	8.000	(203)
	45°	5.590	(142)	8.025	(204)	10.195	(259)	10.445	(265)
	90°	6.571	(167)	9.397	(239)	12.395	(315)	12.645	(321)
	180°	8.533	(217)	12.142	(308)	16.796	(427)	17.046	(433)
	270°	10.495	(267)	14.887	(378)	21.197	(538)	21.447	(545)
	360°	12.457	(316)	17.632	(448)	25.598	(650)	25.848	(657)
	Add per °	.0218	(0.55)	.0305	(0.77)	.0489	(1.24)	.0489	(1.24)
AA		.312	(7.92)	.500	(12.70)	.688	(17.48)	1.000	(25.40)
B		2.250	(57)	2.750	(70)	4.000	(102)	4.000	(102)
BB		.093	(2.36)	.125	(3.18)	.187	(4.75)	.187	(4.75)
C		.625	(16)	1.000	(25)	1.000	(25)	1.000	(25)
CC		.047	(1.19)	.060	(1.52)	.093	(2.36)	.093	(2.36)
D		.875	(22)	1.750	(44)	2.031	(52)	2.031	(52)
DD		.234	(5.94)	.250	(6.35)	.500	(12.70)	.500	(12.70)
E		2.250	(57)	2.687	(68)	3.718	(94)	3.718	(94)
EE		.250	(6.35)	.250	(6.35)	.437	(11.10)	.437	(11.10)
F		1.500	(38)	2.000	(51)	2.500	(64)	3.000	(76)
FF		.500	(12.70)	.750	(19.15)	1.125	(28.58)	1.125	(28.58)
G		3.312	(84)	4.375	(111)	6.604	(168)	6.604	(168)
H		1.656	(42)	2.187	(56)	3.302	(84)	3.302	(84)
I		2.406	(61)	3.187	(81)	4.878	(124)	4.878	(124)
J		1.000	(25)	1.500	(38)	1.500	(38)	1.500	(38)
øK		.500	(12.70)	.875	(22.23)	1.125	(28.58)	1.125	(28.58)
L		.625	(16)	1.500	(38)	1.625	(67)	1.625	(67)
M		1/8 x 1/16		3/16 x 3/32		1/4 x 1/8		1/4 x 1/8	
N		1.500	(38)	1.500	(38)	2.000	(51)	2.000	(51)
O		1/4-20		1/4-20		7/16-14		7/16-14	
P		1/8 NPT		1/4 NPT		1/4 NPT		1/4 NPT	
Q		.453	(12)	.594	(15)	.863	(22)	.863	(22)
R		1/4-20		5/16-24		1/2-20		1/2-20	
S		.250	(6)	.250	(6)	.375	(10)	.375	(10)
T		.250	(6)	.313	(8)	.500	(13)	.500	(13)
U		.250	(6)	.438	(11)	.438	(11)	.438	(11)

Rack & Pinion Rotary Actuators

Double Rack & Pinion Rotary Actuator (ø1 1/8" to 2 1/2" Bores)

- **Double Rack and Pinion Rotary Actuators are designed for non-lube added service.**
- **Theoretical torque from 50 to 5500 inch-pounds (5.65 to 621.25 Newton-meters).**
- **Rotation angles 45°, 90°, 180°, 270° and 360° standard.**
- **Urethane Noise Dampening Bumpers optional.**
- **Viton® Seals optional for higher temperatures.**
- **Body Mount or optional Bottom, Front and Rear Flange Mountings.**



Double Rack and Pinion Rotary Actuator Order Information

■ ■ ■ ■ ■ – ■ ■ ■ – ■ ■ ■ ■ ■

1 2 3 4 5 6 7 8 9 10 11 12 13

Bore	
2	1 1/8"
3	1 1/2"
4	2"
5	2 1/2"

Rack/Rotary Type	
2	Double Rack Low Friction Seals
5	Double Rack Standard Seals
6	Standard Air/Oil Tandem
7	Integral Air/Oil Tandem
X	Special

Multiple Position Actuator	
0	2 Position
3	3 Position
4	4 Position
5	5 Position
X	Special

Rotation	
A	45°
B	90°
C	180°
D	270°
E	360°
X	Special

Output Shaft	
A	Single End Keyway Standard
B	Double End Keyway
C	Hollow Internal Keyway
D	Cross Keyway
E	Preloaded Keyway
X	Special

Mounting	
1	Standard
2	Front Flange
3	Rear Flange
4	Bottom Flange
X	Special

Port Size & Location					
Position	1	2	3	4	5
Standard	A	B*	C	D	F
Oversized	E	G	H	J	K
Special	X				

*Standard Port Size and Location.

Options	
0	No Option
E	Electroless Nickel
P	Loaded Piston Seals
V	Viton® Seals
X	Special (Specify)

Magnetic Option	
0	No Magnet
M	Standard Magnetic Piston in Position A & B Integral Air/Oil Tandems in Position B & D

NOTE: See page 21 for information on switches.

Rotation Adjustments	
1	No Adjustment
2	End Cap A
3	End Cap B
4	End Caps A & B
5	End Caps B & D
X	Special

NOTE: Standard rotation adjustments provide 30° of angle reduction.

Bumper	
A	No Bumpers
B	End Cap A
C	End Cap B
D	All Caps
X	Special

Flow Controls				
Needle Position	1	2	3	4
No Flow Controls	A			
End Cap A	B	C	D	E
End Cap B	G	H	J	K
End Caps A & B	M	N	P	R
Special	X			

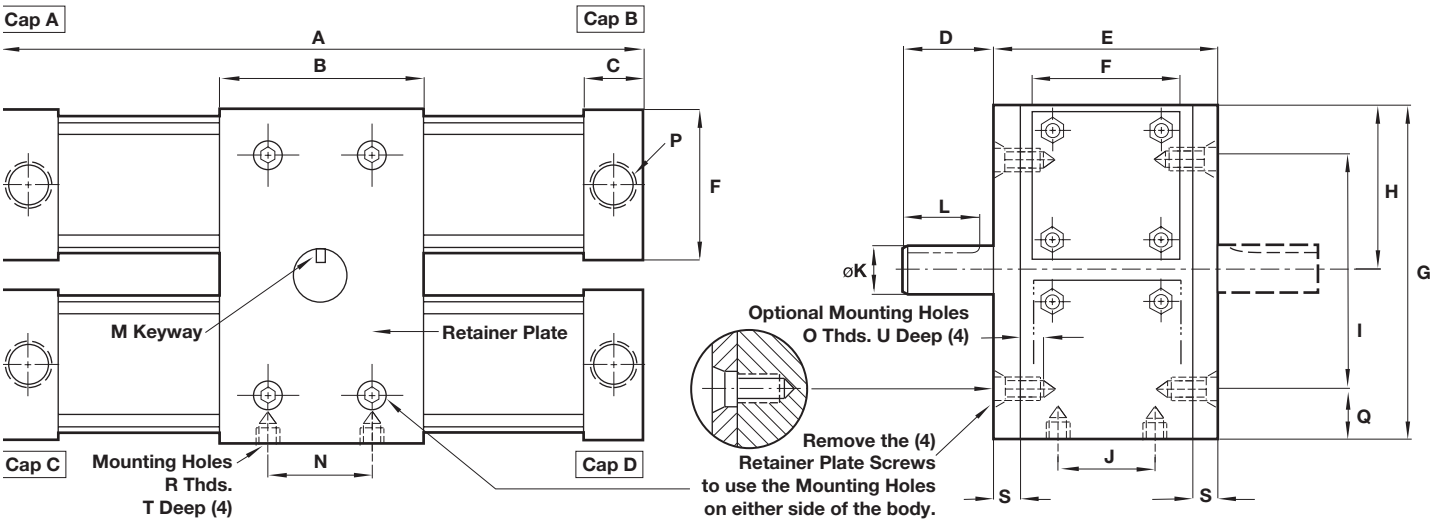
NOTE: Flow Controls must be 90° to Port Location. Flow controls are Standard on all Air/ Oil Tandems. Standard Air/ Oil Tandem Flow Controls are in end caps A & C in position #2. Integral Air/ Oil Tandem Flow Controls are in position #5.

Cushions				
Needle Position	1	2	3	4
No Cushions	A			
End Cap A	B	C	D	E
End Cap B	G	H	J	K
End Caps A & B	N	M	P	R
Special	X			

NOTE: Cushions & Rotation Adjustment cannot be located in same end cap.

See ACT-12-20 for complete instructions on how to order Mini Rotary Actuators.

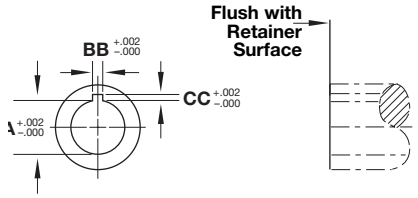
Basic Dimensions Double Rack and Pinion Rotary Actuator



Shaft Options

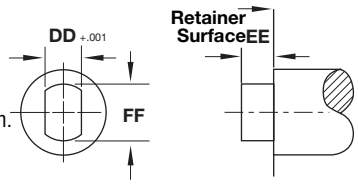
Internal Keyed Hollow

Shaft can be utilized from either side and is flush with retaining plates.
2" bore – 1.00" (25.4) hollow-optional
2 1/2" bore – .688" (17.48) hollow-optional



Cross Keyed

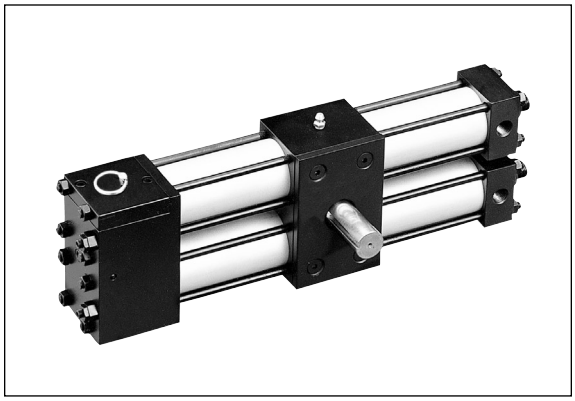
Shaft protrudes from retainer EE dimension.

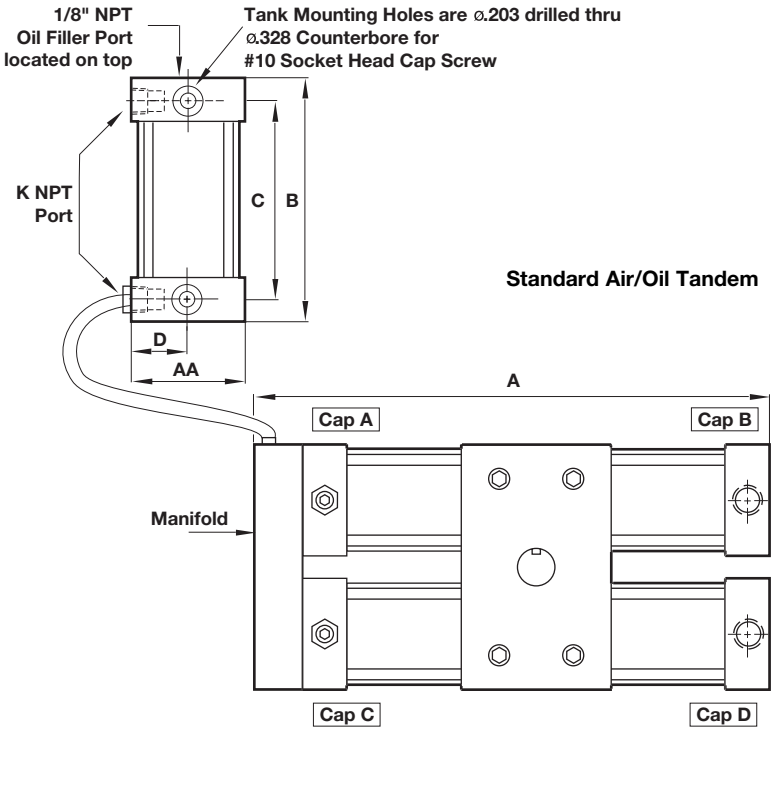


Dimension	Degree Rotation	1 1/8" Bore Double Rack		1 1/2" Bore Double Rack		2" Bore Double Rack		2 1/2" Bore Double Rack	
A	0°	4.500	(114)	6.500	(165)	7.750	(197)	8.000	(203)
	45°	5.590	(142)	8.025	(204)	10.195	(259)	10.445	(265)
	90°	6.571	(167)	9.397	(239)	12.395	(315)	12.645	(321)
	180°	8.533	(217)	12.142	(308)	16.796	(427)	17.046	(433)
	270°	10.495	(267)	14.887	(378)	21.197	(538)	21.447	(545)
	360°	12.457	(316)	17.632	(448)	25.598	(650)	25.848	(657)
	Add per °	.0218	(0.55)	.0305	(0.77)	.0489	(1.24)	.0489	(1.24)
AA		.312	(7.92)	.500	(12.70)	.688	(17.48)	1.000	(25.40)
B		2.250	(57)	2.750	(70)	4.000	(102)	4.000	(102)
BB		.093	(2.36)	.125	(3.18)	.187	(4.75)	.187	(4.75)
C		.625	(16)	1.000	(25)	1.000	(25)	1.000	(25)
CC		.047	(1.19)	.060	(1.52)	.093	(2.36)	.093	(2.36)
D		.875	(22)	1.750	(44)	2.031	(52)	2.031	(52)
DD		.234	(5.94)	.250	(6.35)	.500	(12.70)	.500	(12.70)
E		2.250	(57)	2.687	(68)	3.718	(94)	3.718	(94)
EE		.250	(6.35)	.250	(6.35)	.437	(11.10)	.437	(11.10)
F		1.500	(38)	2.000	(51)	2.500	(64)	3.000	(76)
FF		.500	(12.70)	.750	(19.15)	1.125	(28.58)	1.125	(28.58)
G		3.312	(84)	4.375	(111)	6.604	(168)	6.604	(168)
H		1.656	(42)	2.187	(56)	3.302	(84)	3.302	(84)
I		2.406	(61)	3.187	(81)	4.878	(124)	4.878	(124)
J		1.000	(25)	1.500	(38)	1.500	(38)	1.500	(38)
øK		.500	(12.70)	.875	(22.23)	1.125	(28.58)	1.125	(28.58)
L		.625	(16)	1.500	(38)	1.625	(67)	1.625	(67)
M		1/8 x 1/16		3/16 x 3/32		1/4 x 1/8		1/4 x 1/8	
N		1.500	(38)	1.500	(38)	2.000	(51)	2.000	(51)
O		1/4-20		1/4-20		7/16-14		7/16-14	
P		1/8 NPT		1/4 NPT		1/4 NPT		1/4 NPT	
Q		.453	(12)	.594	(15)	.863	(22)	.863	(22)
R		1/4-20		5/16-24		1/2-20		1/2-20	
S		.250	(6)	.250	(6)	.375	(10)	.375	(10)
T		.250	(6)	.313	(8)	.500	(13)	.500	(13)
U		.250	(6)	.438	(11)	.438	(11)	.438	(11)

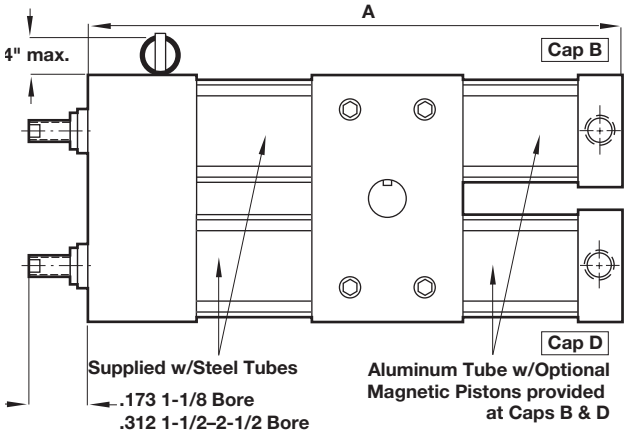
Standard Air/Oil Tandem is supplied with an Air/Oil Tank.

- **Air/Oil Tank should have 20 PSI pressure header.**
- **Integral Air/Oil Tandem is fully self-contained.**
- **The simplicity of compressed air with the smooth control of hydraulics.**
- **Provides extremely smooth, fully adjustable speed control of the actuator output shaft.**





Standard Air/Oil Tandem



Integral Air/Oil Tandem
Refer to ACT-12-12 for Operating Principle.

Length Dimensions for Air/Oil Tandems

Dimension	Degree Rotation	1 1/8" Standard		1 1/2" Standard		2" Standard		2 1/2" Standard	
A	0°	5.125	(130)	7.500	(191)	8.750	(222)	9.000	(229)
	45°	6.215	(158)	9.025	(292)	11.195	(284)	11.445	(291)
	90°	7.196	(183)	10.397	(264)	13.395	(340)	13.645	(347)
	180°	9.158	(233)	13.142	(333)	17.796	(452)	18.046	(458)
	270°	11.121	(282)	15.887	(404)	22.197	(563)	22.447	(570)
	360°	13.082	(332)	18.632	(473)	26.598	(676)	26.848	(682)
Dimension	**Degree Rotation**	**1 1/8" Integral**		**1 1/2" Integral**		**2" Integral**		**2 1/2" Integral**	
A	0°	6.125	(156)	8.000	(203)	9.500	(241)	10.000	(254)
	45°	7.215	(183)	9.525	(242)	11.945	(303)	12.445	(316)
	90°	8.196	(208)	10.897	(277)	14.145	(359)	14.645	(372)
	180°	10.158	(258)	13.642	(347)	18.546	(471)	19.046	(484)
	270°	12.120	(308)	16.387	(416)	22.947	(583)	23.447	(596)
	360°	14.082	(358)	19.132	(486)	27.348	(695)	27.848	(707)
	Add per °	.0218	(1)	.0305	(1)	.0489	(1)	.0489	(1)

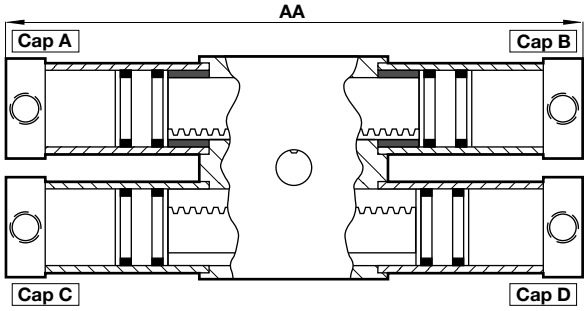
Dimensions for Air/Oil Tanks

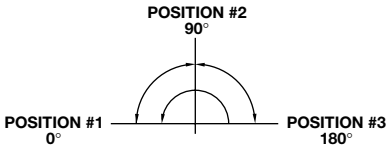
Rotary Actuator Bore Size	Air/Oil Tank Model Number	Tank Bore Size	AA		B		C		D		K
1 1/8"	AOT-225X2	1 1/8"	1.500	(38)	3.125	(79)	2.750	(70)	.750	(19)	1/8" NPT
1 1/2"	AOT-225X3	1 1/8"	1.500	(38)	4.125	(105)	3.750	(95)	.750	(19)	1/8" NPT
2"	AOT-225X4	1 1/8"	1.500	(38)	5.125	(130)	4.750	(121)	.750	(19)	1/8" NPT
2 1/2"	AOT-225X5	1 1/8"	1.500	(38)	6.125	(156)	5.750	(146)	.750	(19)	1/8" NPT

Multiple Position Rack and Pinion Rotary Actuators are capable of producing 3, 4, or 5 predetermined output shaft positions. Each intermediate stop position specified is mechanically locked and therefore not adjustable. Use of optional rotation adjustments at the full clockwise and counterclockwise positions will provide up to 30° of angular reduction at each end.

The alternate pressurizing and exhausting of various actuator ports will determine which output shaft position is obtained. This can be accomplished with the use of simple, directional control valving and allows output shaft positioning in virtually **ANY** desired sequence.

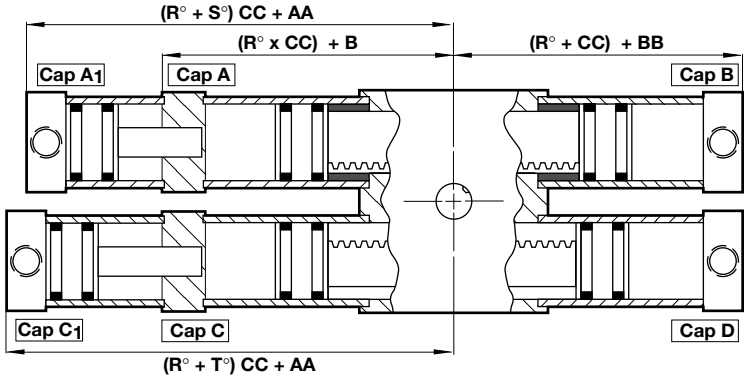
3 Position Rotary Actuator

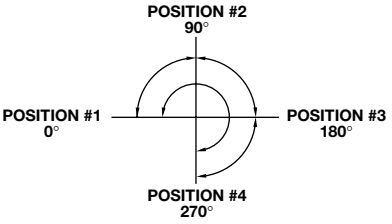




Output Shaft Position Number	Pressurize Port(s) in Cap(s))	Exhaust
1	C	All other ports
2	A & B	All other ports
3	D	All other ports

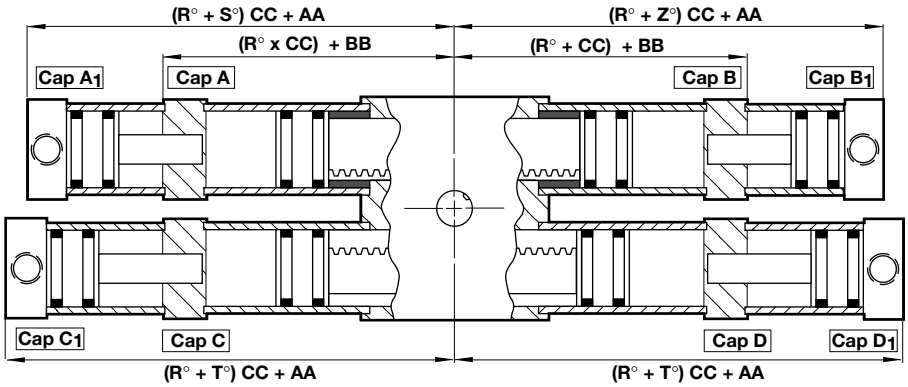
4 Position Rotary Actuator

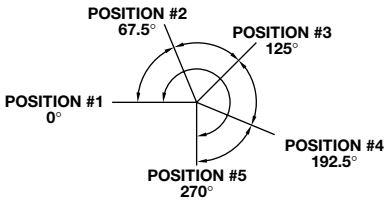




Output Shaft Position Number	Pressurize Port(s) in Cap(s)	Exhaust
1	C	All other ports
2	A_1 & C_1	All other ports
3	A & B	All other ports
4	D	All other ports

5 Position Rotary Actuator





Output Shaft Position Number	Pressurize Port(s) in Cap(s)	Exhaust
1	C	All other ports
2	A_1 & C_1	All other ports
3	A & B	All other ports
4	B_1 & D_1	All other ports
5	D	All other ports

4-Position Rotary Actuator

R° = Rotation of base unit in degrees (Positions 1 and 4)
S° = Change in rotation of base unit (Position 2)
T° = Change in rotation of base unit (Position 3)

5-Position Rotary Actuator Total

R° = Rotation of base unit in degrees
S° = Change in rotation of base unit (Position 2)
T° = Change in rotation of base unit (Position 3)
Z° = Change in rotation of base unit (Position 4)

Dimension	1 1/8"		1 1/2"		2"		2 1/2"	
AA	3.625	(92)	5.375	(54)	6.000	(152)	6.250	(159)
BB	2.250	(57)	3.250	(83)	3.875	(98)	4.000	(102)
CC	.011	(.28)	.015	(.38)	.024	(.61)	.024	(.61)

NOTE: The 3-position actuator dimensions are the same as a standard 2-position unit. Keyway in position shown is at midpoint of rotation.

Rack and Pinion Rotary Actuator Order Information

2	5	0	C	B	–	1	B	B	–	A	D	3	M	E
1	2	3	4	5		6	7	8		9	10	11	12	13

Bore	
2	**1 1/8"**
3	1 1/2"
4	2"
5	2 1/2"

Rack/Rotary Type	
0	Single Rack Standard Seals
1	Single Rack Low Friction Seals
2	Double Rack Low Friction Seals
5	**Double Rack Standard Seals**
6	Standard Air/Oil Tandem
7	Integral Air/Oil Tandem
X	Special

Multiple Position Actuator	
0	**2 Position**
3	3 Position
4	4 Position
5	5 Position
X	Special

Rotation	
A	45°
B	90°
C	**180°**
D	270°
E	360°
X	Special

Output Shaft	
A	Single End Keyway Standard
B	**Double End Keyway**
C	Hollow Internal Keyway
D	Cross Keyway
E	Preloaded Keyway
X	Special

Mounting	
1	**Standard**
2	Front Flange
3	Rear Flange
4	Bottom Flange
X	Special

Port Location					
Position	1	2	3	4	5
Standard	A	**B***	C	D	F
Oversized	E	G	H	J	K
Special	X				

*Standard Port Size and Location.

Options	
0	No Option
E	**Electroless Nickel**
P	O-Ring Loaded Piston Seals
V	Viton® Seals
X	Special (Specify)

Magnetic Option	
0	No Magnet
M	**Standard Magnetic Piston in Position A & B** **Integral Air/Oil Tandems in Position B & D**

NOTE: See ACT-12-21 for information on switches.

Rotation Adjustments	
1	No Adjustment
2	End Cap A
3	**End Cap B**
4	End Caps A & B
5	End Caps B & D
X	Special

NOTE: Standard rotation adjustments provide 30° of angle reduction.

Bumper	
A	No Bumpers
B	End Cap A
C	End Cap B
D	**All Caps**
X	Special

Flow Controls				
Needle Position	1	2	3	4
No Flow Controls	**A**			
End Cap A	B	C	D	E
End Cap B	G	H	J	K
End Caps A & B	M	N	P	R
Special	X			

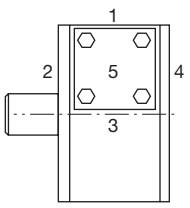
NOTE: Flow Controls must be 90° to Port Location. Flow controls are Standard on all Air/ Oil Tandems. Standard Air/ Oil Tandem Flow Controls are in end caps A & C in position #2. Integral Air/ Oil Tandem Flow Controls are in position #5.

Cushions				
Needle Position	1	2	3	4
No Cushions	A			
End Cap A	**B**	C	D	E
End Cap B	G	H	J	K
End Caps A & B	N	M	P	R
Special	X			

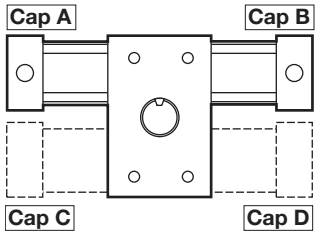
NOTE: Cushions & Rotation Adjustment cannot be located in same end cap.

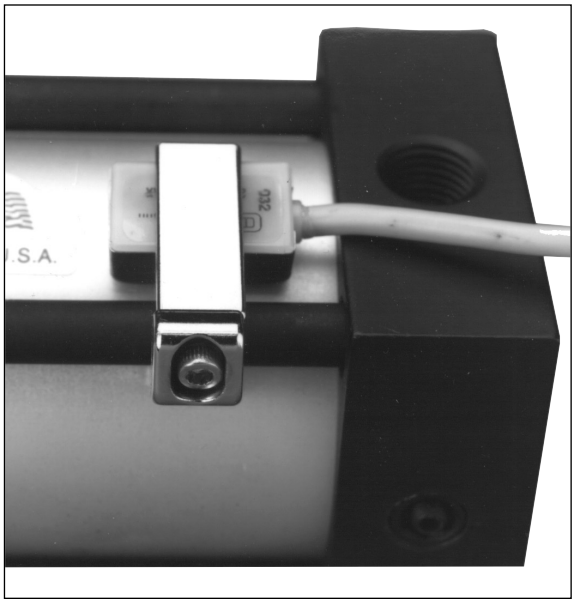
EXAMPLE: 1 1/8" Bore – Double Rack with Standard Seals – 2 Position Rotary Actuator – 180° Rotation – Double End Keyway – Standard Mounting – Standard Port Located at Position 2 – Cushion Position 1 in End Cap A – No Flow Controls – Bumpers on All Caps – End Cap B Rotation Adjustments – Standard Magnetic Piston Option – Electroless Nickel Plated.

Port position available in Positions 1-5
Cushion Needle position available in Positions 1-4



End Cap Designations
(As viewed facing output shaft)

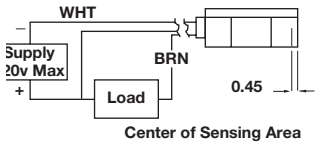
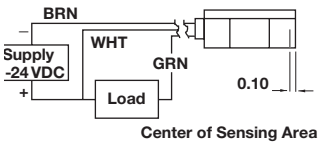
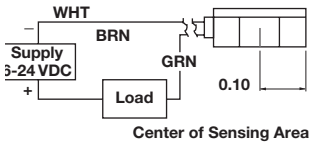




- **Magnetically operated, non-contact sensing system.**
- **Consists of a magnet in the piston, and a sensing switch clamped on the actuator tie rod.**
- **One or more switches may be mounted to provide an indication of piston position or to control or initiate any sequence function.**
- **Adjustable mounting brackets are standard, and allow switches to be securely positioned anywhere along the range of piston travel.**
- **LED indicator light facilitates installation and troubleshooting.**

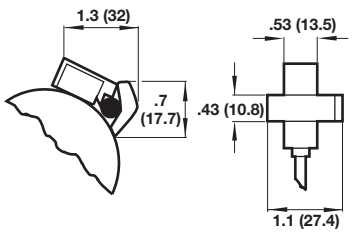
Specifications

*Metal Oxide Varsitor Surge Suppression. **NOTE:** All CS8 Series Switches are supplied with 9 foot leads.

Switch Model	CS8-2-04 Reed	CS8-2-31 Solid State	CS8-2-32 Solid State
Bore Sizes	1 1/8" thru 2 1/2"	1 1/8" thru 2 1/2"	1 1/8" thru 2 1/2"
Switch Type	Reed Switch *MOV & Light	Solid State & Light, Sourcing PNP	Solid State & Light, Sinking NPN
Function	SPST Normally Open	Normally Open	Normally Open
Switching Voltage	5-120 VDC/VAC 50/60 Hz	6-24 VDC	6-24 VDC
Switching Current	.5 Amp Max .005 Amp Min	.5 Amp Max	.5 Amp Max
Switching Power	10 VA	12 Watts Max	12 Watts Max
Max Voltage Drop	3.5 Volts	.5 Volts	.5 Volts
Magnetic Sensitivity	85 Gauss	85 Gauss	85 Gauss
Enclosure Classification	NEMA 6 & CSA Approved	NEMA 6 & CSA Approved	NEMA 6 & CSA Approved
Temperature Range	-22°F to +176°F	-22°F to +176°F	-22°F to +176°F
Wiring Diagrams			

Switch & Mounting Bracket Dimensions

CS8-2 Series



All Dimensions in Inches (mm)

Application Recommendations and Precautions

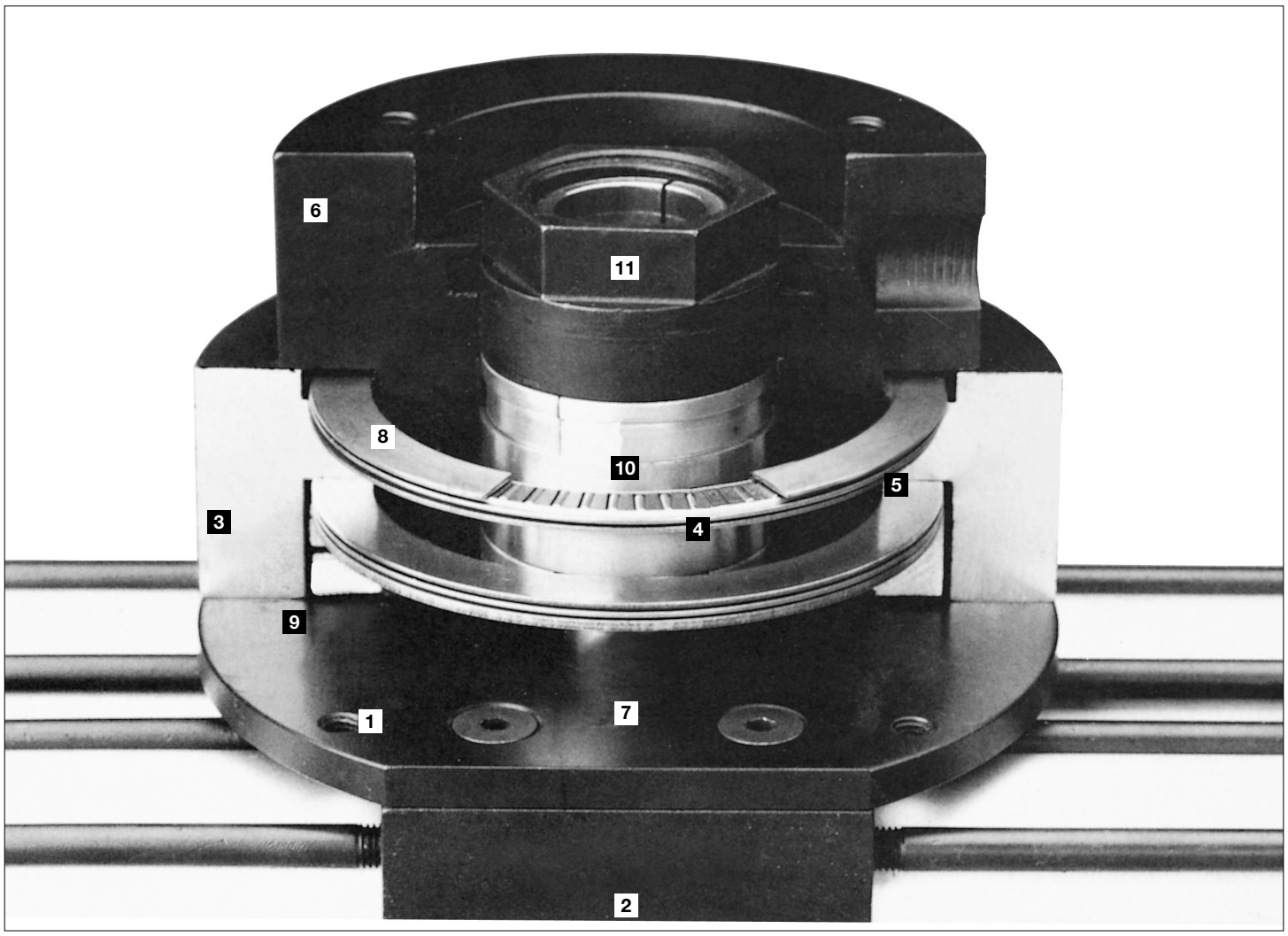
To provide maximum reliability:

1. Always stay within the specifications and power rating limitations of the unit installed.
2. Primary and control circuit wiring should not be mixed in the same conduit. Motors will produce high pulses that will be introduced into the control wiring if the wiring is carried in the same conduit.
3. Never connect the switch without a load present. The switch will be destroyed.
4. Some electrical loads may be capacitive. Capacitive loading may occur due to distributed capacity in cable runs over 25 feet. Use switch Model CS7-24 whenever capacitive loading may occur. Refer to NCA-60 catalog.

In order to obtain optimum performance and long life, magnetically operated limit switches should not be subjected to: (1) strong magnetic fields, (2) extreme temperature, and (3) excessive ferrous filing or chip buildup.

Improper wiring may damage or destroy the switch. The wiring diagram, along with the listed power ratings, must be carefully observed before connecting power to the switch.

Lower power switches are designed for signaling electronic circuits. Do not use on relay loads or with incandescent bulbs. Resistive loads only.



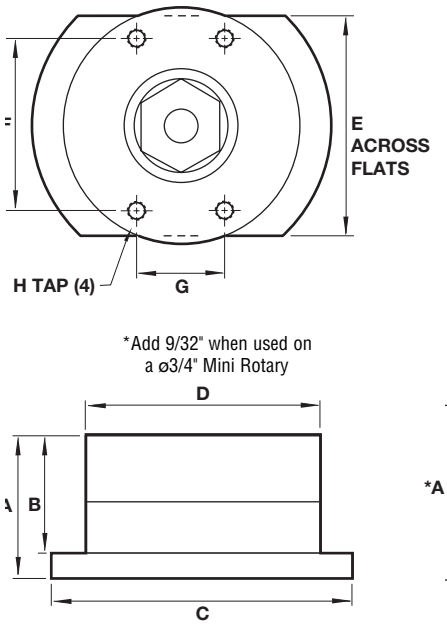
A **1 Rotary Table Flange** is attached to the body of a **2 Rotary Actuator** to create a mounting surface for the rotary table assembly. This assembly consists of a **3 Table Housing** machined from 6061-T6 aluminum alloy. This housing is specifically designed to incorporate two individual **4 Thrust Bearings**, each sandwiched between two steel **5 Surface Washers.** These bearings accept axial and radial loads that are applied to the rotary table assembly.

The **6 Hub**, also machined from 6061-T6 aluminum alloy, is centrally positioned over the actuator **7 Output Shaft.** A **8 Wear Band** located on the hub enhances load carrying capability. The **9 Slotted Locking Ring** retains the hub and thrust bearings to the table housing.

Attachment of the hub to the actuator output shaft is accomplished by a **10 Coupler.** The coupler is a simple, keyless design consisting of an inner collet-like element, an outer sleeve set and a **11 Hex Nut.** The inner and outer elements have matching opposing tapers. As the hex nut is tightened, the coupler elements expand ***and*** contract radially, locking the hub to the output shaft. In this locked condition, the output shaft and hub act as a single unit, allowing the rotational forces (torque) of the output shaft to be directly transmitted to the hub.

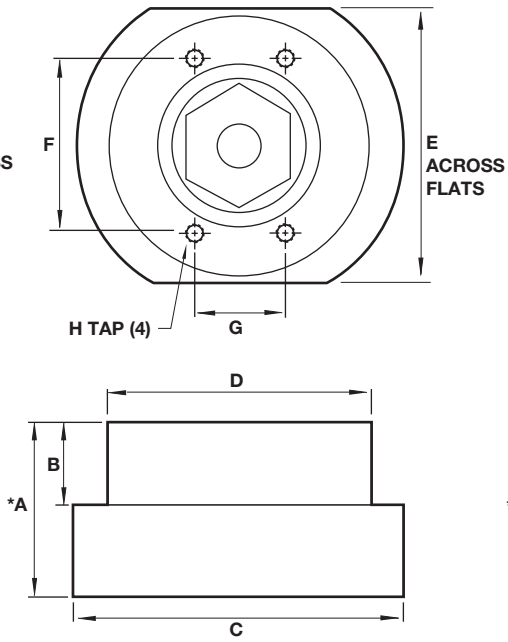
The keyless design of the coupler allows infinite positioning of the tapered holes located in the hub. These holes enable either vertical or horizontal mounting of a **Series N** Non-Rotating Rod Cylinder (***Section 4***).

MM-1



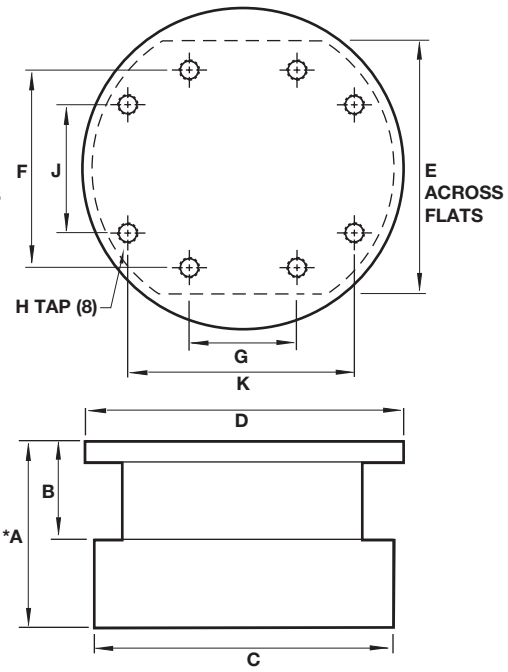
Coupler Hex Size: 7/8"

MM-2



Coupler Hex Size: 1-1/2"

MM-3



Coupler Hex Size: 2"

MM-1 Rotary Table

Use with ø3/4" or ø1 1/8" Bore Rotary Actuator. Accepts 1 1/8" Bore **Series N (Section 4).** With Rotary Table Plate **MM-80-03,** accepts 1 1/2" Bore **Series N (Section 4).**
NOTE: When interfacing with ø3/4" Bore Mini Rotary Actuator, a ***Double Rack*** model is recommended.

MM-2 Rotary Table

Use with ø1 1/2" Bore Rotary Actuator. Accepts 1 1/2" Bore **Series N (Section 4).** With Rotary Table Plate **MM-80-04,** accepts 2" or 2 1/2" Bore **Series N (Section 4).**

MM-3 Rotary Table

Use with ø2" or ø2 1/2" Bore Rotary Actuator. (Rotary Table Plate **MM-80-04,** comes standard). Accepts 1 1/2" Bore **Series N (Section 4)** without Rotary Table Plate **MM-80-04.** Accepts 2" or 2 1/2" Bore **Series N (Section 4)** with Rotary Table Plate **MM-80-04.**

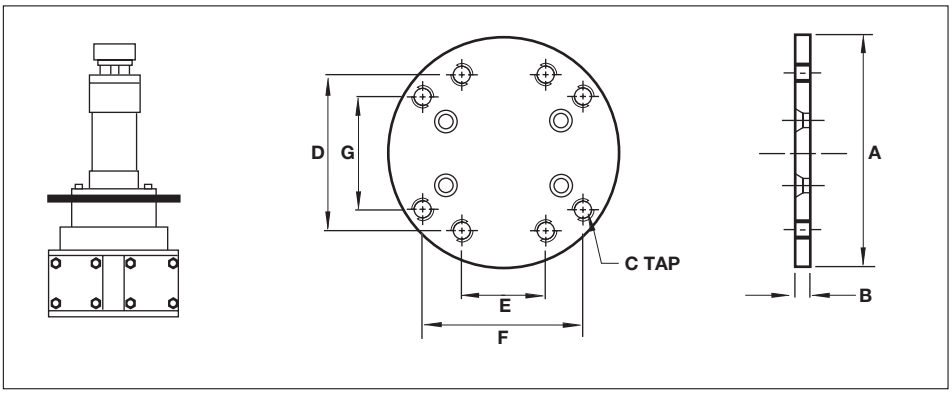
Rotary Table Dimensions

Rotary Table	A	B	C	D	E	F	G	H	J	K
MM-1	1.625 (41)	1.344 (34)	3.438 (87)	2.688 (68)	2.500 (64)	2.000 (51)	1.000 (25)	10 – 32	–	–
MM-2	2.807 (71)	1.328 (34)	5.125 (130)	4.125 (108)	4.355 (111)	2.750 (70)	1.428 (36)	1/4 – 28	–	–
MM-3	4.117 (105)	2.638 (67)	5.125 (130)	5.500 (140)	4.355 (111)	3.375 (86)	1.838 (47)	5/16 – 24	2.192 (56)	3.875 (98)

Optional Rotary Table Plate

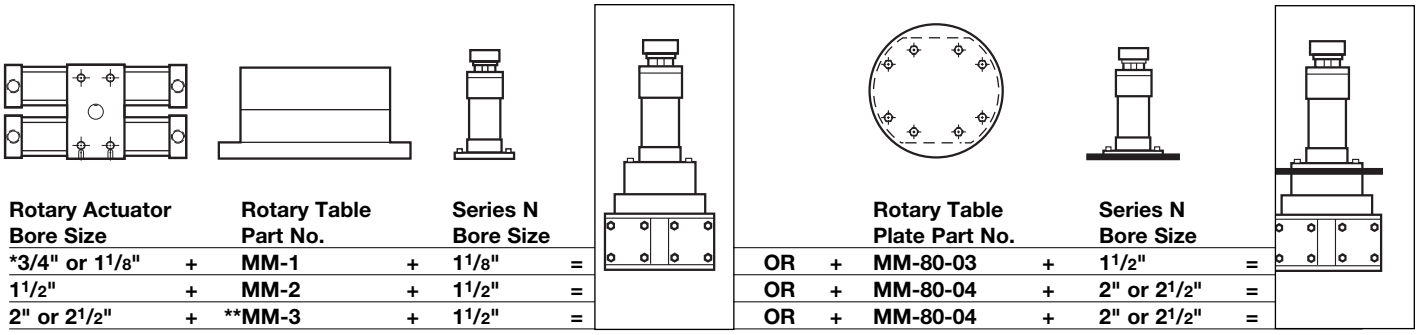
Larger than standard rear flange mounting patterns for the MM-1 and MM-2 Rotary Tables are available by the simple interface of the optional Rotary Table Plate.

When using optional rotary table plate:
MM-1 accepts Series N 1 1/2" Bore
MM-2 accepts Series N 2" or 2 1/2" Bore
MM-3 accepts Series N 2" or 2 1/2" Bore
Refer to Section 4.

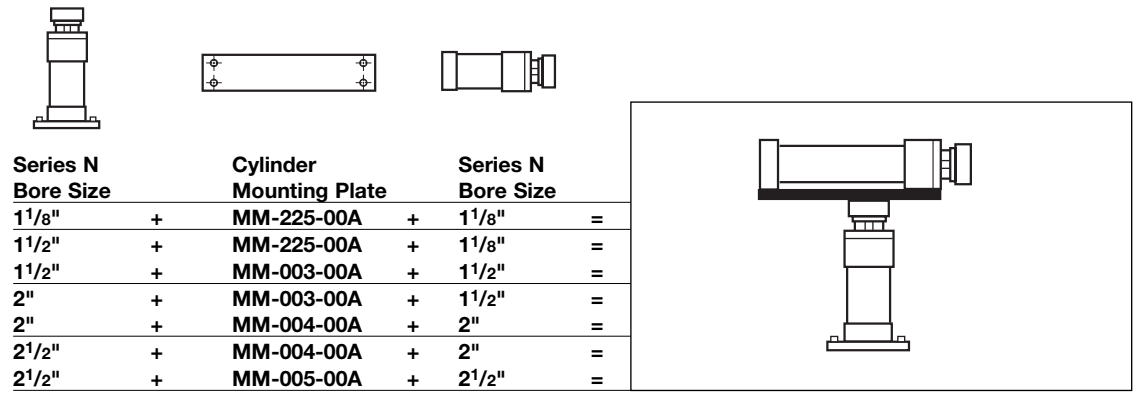


Rotary Table Plate Part #	Use with Rotary Table	A	B	C	D	E	F	G
MM-80-03	**MM-1**	4.000 (102)	.250 (6)	1/4 – 28	2.750 (70)	1.428 (36)	–	–
MM-80-04	**MM-2**	5.500 (140)	.375 (10)	5/16 – 24	3.375 (86)	1.838 (47)	3.875 (98)	2.192 (56)
MM-80-04	**MM-3**	5.500 (140)	.375 (10)	5/16 – 24	3.375 (86)	1.838 (47)	3.875 (98)	2.192 (56)

Norgren Motion Modules may be assembled in a number of single or multi-axis configurations to provide a wide range of linear and rotary movements. The selection guide shown below is intended to graphically assist in the interface of appropriate MOTION MODULES and ACCESSORIES required to accomplish the specific configurations. MOTION MODULES afford such total design flexibility that the selection guide has been limited to only the more basic MOTION MODULE assemblies.

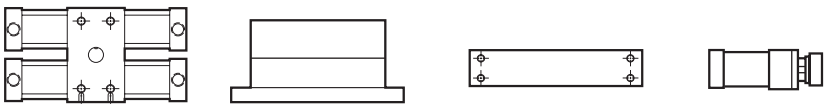


Rotary Actuator Bore Size		Rotary Table Part No.		Series N Bore Size			Rotary Table Plate Part No.		Series N Bore Size	
*3/4" or 1 1/8"	+	MM-1	+	1 1/8"	=	OR	+ MM-80-03	+	1 1/2"	=
1 1/2"	+	MM-2	+	1 1/2"	=	OR	+ MM-80-04	+	2" or 2 1/2"	=
2" or 2 1/2"	+	**MM-3	+	1 1/2"	=	OR	+ MM-80-04	+	2" or 2 1/2"	=



Series N Bore Size		Cylinder Mounting Plate		Series N Bore Size	
1 1/8"	+	MM-225-00A	+	1 1/8"	=
1 1/2"	+	MM-225-00A	+	1 1/8"	=
1 1/2"	+	MM-003-00A	+	1 1/2"	=
2"	+	MM-003-00A	+	1 1/2"	=
2"	+	MM-004-00A	+	2"	=
2 1/2"	+	MM-004-00A	+	2"	=
2 1/2"	+	MM-005-00A	+	2 1/2"	=

Series N Bore Size		Modular Adaptor Plate		Mini Rotary Actuator Bore Size			Angle Bracket		Mini Rotary Actuator Bore Size	
1 1/8"	+	NB-172-225K	+	1/2" or 3/4"=	OR	+	R-920-100	+	1/2" or 3/4"	=
1 1/2"	+	NB-172-03K	+	1/2" or 3/4"=	OR	+	R-920-100	+	1/2" or 3/4"	=
2"	+	NB-172-04K	+	1/2" or 3/4"=	OR	+	R-920-100	+	1/2" or 3/4"	=
2 1/2"	+	NB-172-05K	+	1/2" or 3/4"=	OR	+	R-920-100	+	1/2" or 3/4"	=



Rotary Actuator		Rotary Table		Cylinder Mounting Plate		Series N Bore Size	
*3/4" or 1 1/8"	+	MM-1	+	MM-225-00A	+	1 1/8"	=
1 1/2"	+	MM-2	+	MM-003-00A	+	1 1/2"	=
1 1/2"	+	MM-2	+	MM-004-00A	+	2"	=
1 1/2"	+	MM-2	+	MM-005-00A	+	2 1/2"	=
2"	+	MM-3	+	MM-003-00A	+	1 1/2"	=
2"	+	MM-3	+	MM-004-00A	+	2"	=
2"	+	MM-3	+	MM-005-00A	+	2 1/2"	=
2 1/2"	+	MM-3	+	MM-003-00A	+	1 1/2"	=
2 1/2"	+	MM-3	+	MM-004-00A	+	2"	=
2 1/2"	+	MM-3	+	MM-005-00A	+	2 1/2"	=

*When interfacing MM-1 Rotary Table with 3/4" bore Mini Rotary Actuator, a double rack model is recommended.

**Rotary Table MM-3 includes Rotary Table Plate No. MM-80-04. Remove Rotary Table MM-80-04 to use 1 1/2" Series N.

Rotary Table Weights & Hex Nut Installation Torques

Rotary Table	Rotary Table Weight Pounds	(Kilograms)	Hex Nut Installation Torque in Foot-Pounds	(Newton-meters)
MM-1	1.125	(0.511)	30 ft. lbs.	(40.66)
MM-2	5.5625	(2.525)	160 ft. lbs.	(216.87)
MM-3	7.875	(3.575)	240 ft. lbs.	(325.31)

NOTE: All Rotary Tables are supplied with a torque bar to simplify coupler installation.

How to Order Rotary Tables

Order Rotary Table	When Interfacing with this size Rotary Actuator
MM-1	*3/4" or 1-1/8"
MM-2	1-1/2"
MM-3	2" or 2-1/2"

NOTE: *When interfacing MM-1 Rotary Table with 3/4" Bore Mini Rotary Actuator, a ***double rack*** model is recommended.

Consolidated Motion Module Torque Output and Force Data

Rotary Table Model MM-1

Input Pressure		Rotary Actuator Torque Output in Inch-pounds per PSI (Newton-meters per Bar)								**Series N** Extend & Retract Forces in Pounds (Newtons)							
		3/4" Bore				1-1/8" Bore				1-1/8" Bore				1-1/2" Bore			
PSI	(bar)	Single		Double		Single		Double		Extend		Retract		Extend		Retract	
30	(2)	4.9	(8.03)	9.9	(16.21)	18.7	(30.62)	37.4	(61.25)	29.9	(132.00)	26.9	(119.65)	53.1	(236.19)	46.5	(206.83)
40	(3)	6.6	(10.80)	13.2	(21.62)	24.9	(40.78)	49.8	(81.56)	39.8	(177.03)	35.9	(159.68)	70.8	(314.92)	61.8	(274.89)
50	(3.5)	8.3	(13.59)	16.5	(27.02)	31.1	(50.93)	62.3	(102.04)	49.8	(221.51)	44.9	(199.72)	88.5	(393.65)	77.3	(343.83)
60	(4)	9.9	(16.21)	19.8	(32.43)	37.3	(61.09)	74.6	(122.18)	59.7	(265.55)	53.8	(239.30)	106.2	(472.38)	92.8	(412.77)
70	(5)	11.6	(18.99)	23.1	(37.83)	43.6	(71.41)	87.1	(142.66)	69.7	(310.03)	62.8	(279.33)	123.9	(551.11)	108.5	(482.61)
80	(6)	13.3	(21.78)	26.6	(43.57)	49.8	(81.56)	99.6	(163.12)	79.6	(354.06)	71.8	(319.37)	141.6	(629.84)	123.7	(550.22)
90	(6.2)	14.9	(24.40)	29.8	(48.80)	56.0	(91.72)	112.0	(183.44)	89.6	(398.54)	80.7	(358.95)	159.3	(708.57)	139.5	(620.50)
100	(7)	16.5	(27.02)	33.0	(54.05)	62.2	(101.87)	124.4	(203.75)	99.5	(442.48)	89.7	(398.99)	177.0	(787.30)	154.6	(687.60)
125	(8.6)	20.7	(33.90)	41.4	(67.81)	77.7	(127.26)	155.4	(254.52)	124.4	(553.33)	112.1	(498.62)	221.3	(984.34)	193.3	(859.80)
150	(10)	24.8	(40.62)	49.6	(81.24)	93.3	(152.81)	186.6	(305.62)	149.2	(663.64)	134.6	(598.70)	265.5	(1180.94)	231.9	(1031.49)

Rotary Table Model MM-2

Input Pressure		Rotary Actuator Torque Output in Inch-pounds per PSI (Newton-meters per Bar)				**Series N** Extend & Retract Forces in Pounds (Newtons)											
		1-1/2" Bore				1-1/2" Bore				2" Bore				2-1/2" Bore			
PSI	(bar)	Single		Double		Extend		Retract		Extend		Retract		Extend		Retract	
30	(2)	46.5	(76.16)	93.0	(152.32)	53.1	(236.19)	46.5	(206.83)	94.2	(482.61)	82.5	(366.96)	147.3	(655.19)	129.0	(573.79)
40	(3)	62.0	(101.55)	124.0	(203.09)	70.8	(314.92)	61.8	(274.89)	125.6	(558.67)	109.9	(488.35)	196.4	(873.59)	171.8	(764.16)
50	(3.5)	77.5	(126.93)	155.0	(253.87)	88.5	(393.65)	77.3	(343.83)	157.0	(698.34)	137.4	(611.16)	245.5	(1091.98)	214.8	(955.30)
60	(4)	92.9	(152.16)	185.8	(304.31)	106.2	(472.38)	92.8	(412.77)	188.4	(838.35)	164.9	(733.47)	294.6	(1310.38)	257.8	(1146.69)
70	(5)	108.5	(177.71)	217.0	(355.41)	123.9	(551.11)	108.5	(482.61)	219.8	(977.67)	192.5	(856.24)	343.7	(1525.97)	301.0	(1338.85)
80	(6)	123.9	(202.93)	247.8	(405.86)	141.6	(629.84)	123.7	(550.22)	251.2	(1117.34)	219.8	(977.67)	392.8	(1747.17)	343.7	(1528.78)
90	(6.2)	139.4	(228.31)	278.8	(456.63)	159.3	(708.57)	139.5	(620.50)	282.6	(1257.00)	247.5	(1100.88)	441.9	(1965.57)	387.0	(1721.38)
100	(7)	154.9	(253.70)	309.8	(507.40)	177.0	(787.30)	154.6	(687.60)	314.0	(1396.67)	274.8	(1222.31)	491.0	(2183.96)	429.6	(1910.86)
125	(8.6)	193.6	(317.08)	387.2	(634.17)	221.3	(984.34)	193.3	(859.80)	392.5	(1754.84)	343.5	(1527.89)	613.8	(2730.18)	537.0	(2388.58)
150	(10)	232.3	(380.47)	464.6	(760.94)	265.5	(1180.94)	231.9	(1031.49)	471.0	(2095.00)	412.2	(1833.10)	736.5	(3275.95)	644.4	(2866.29)

Rotary Table Model MM-3

Input Pressure		Rotary Actuator Torque Output in Inch-pounds per PSI (Newton-meters per Bar)								**Series N** Extend & Retract Forces in Pounds (Newtons)							
		2" Bore				2-1/2" Bore				2" Bore				2-1/2" Bore			
PSI	(bar)	Single		Double		Single		Double		Extend		Retract		Extend		Retract	
30	(2)	131.9	(216.03)	263.8	(432.06)	206.3	(337.88)	412.6	(675.77)	94.2	(482.61)	82.5	(366.96)	147.3	(655.19)	129.0	(573.79)
40	(3)	175.8	(287.93)	351.6	(575.86)	275.0	(450.41)	550.0	(900.81)	125.6	(558.67)	109.9	(488.35)	196.4	(873.59)	171.8	(764.16)
50	(3.5)	219.8	(360.00)	439.5	(719.83)	343.8	(563.09)	687.6	(1126.17)	157.0	(698.34)	137.4	(611.15)	245.5	(1091.98)	214.8	(955.30)
60	(4)	263.8	(431.73)	527.6	(864.12)	412.4	(675.45)	824.8	(1350.89)	188.4	(838.35)	164.9	(733.47)	294.6	(1310.38)	257.8	(1146.69)
70	(5)	307.7	(503.96)	615.3	(1007.76)	481.3	(708.29)	962.6	(1576.59)	219.8	(977.67)	192.5	(856.24)	343.7	(1525.97)	301.0	(1338.85)
80	(6)	351.7	(576.03)	703.4	(1152.06)	549.9	(900.65)	1099.8	(1801.29)	251.2	(1117.34)	219.8	(977.67)	392.8	(1747.17)	343.7	(1528.78)
90	(6.2)	395.6	(647.92)	791.2	(1259.86)	618.7	(1013.33)	1237.4	(2026.66)	282.6	(1257.00)	247.5	(1100.88)	441.9	(1965.51)	387.0	(1721.38)
100	(7)	439.6	(720.00)	879.2	(1439.99)	687.4	(1125.85)	1374.8	(2251.70)	314.0	(1396.67)	274.8	(1222.31)	491.0	(2183.96)	429.6	(1910.86)
125	(8.6)	549.5	(899.99)	1099.0	(1799.99)	859.3	(1407.40)	1718.6	(2814.79)	392.5	(1754.84)	343.5	(1527.89)	613.8	(2730.18)	537.0	(2388.58)
150	(10)	659.4	(1079.99)	1318.8	(2159.98)	1031.1	(1688.78)	2062.2	(3377.56)	471.0	(2095.00)	412.2	(1833.10)	736.5	(3275.95)	644.4	(2866.29)

NOTE: All Rotary Actuator torque outputs and **Series N** Cylinder forces listed above are theoretical. Deduct 10% from these torques and forces to allow for friction loss in actual application. Deduct 20% on all Air/Oil Tandem Rotary Actuators. Air/Oil Tandem and Multiple Position Rotary Actuators utilize a double rack configuration; however, the torque outputs of a single rack unit apply.

$$KE = \frac{J\omega^2}{2}$$

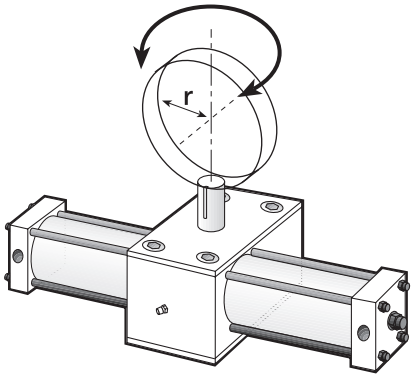
$$\omega = 0.035 \times \frac{\text{Angle traveled (degrees)}}{\text{Rotation time (seconds)}}$$

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** = Acceleration due to gravity = 386.4 in/sec^2
- **r** = Radius of gyration (in)
- **l** = length from point of rotation
- **w** = width

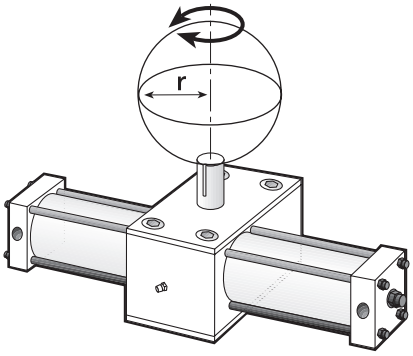
Moments of Inertia

Maximum Kinetic Energy Rating for Model Based on Configuration (in.-lb.)		
Bore	Non-Cushioned	Cushioned
1 1/8""	0.5	5
1 1/2"	2.0	20
2"	4.0	40
2 1/2"	7.0	70



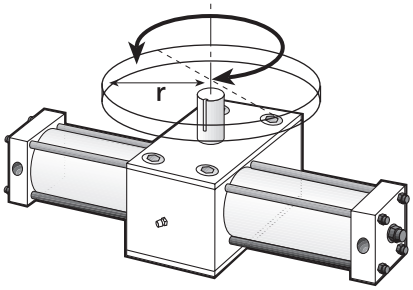
Thin Disk
End mounted on center

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



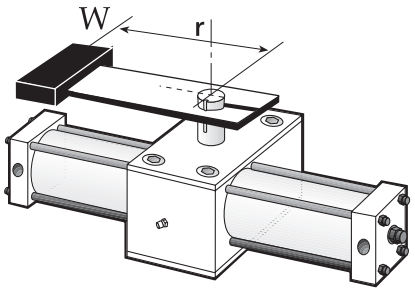
Sphere
Mounted on center

$$J = \frac{W}{g} \times \frac{2r^2}{5}$$



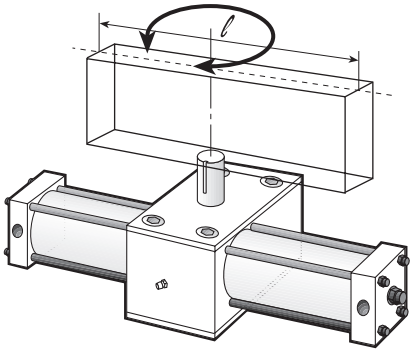
Thin Disk
Mounted on center

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



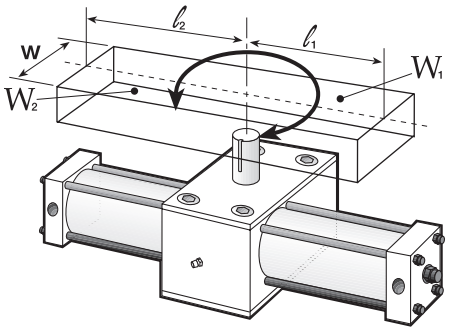
Load off Center (Torque)

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



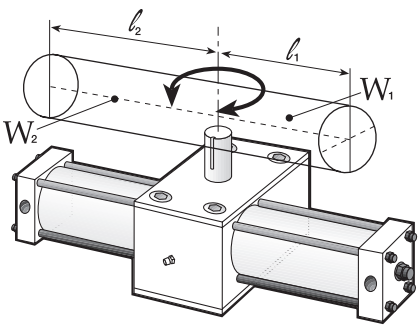
Thin Rectangular Plate
Mounted on center

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



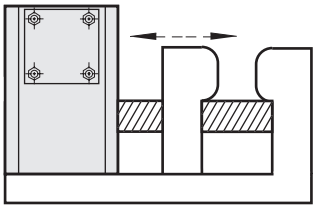
Thin Rectangular Plate

$$J = \frac{W_1}{g} \times \frac{4\ell_1^2 + w^2}{12} + \frac{W_2}{g} \times \frac{4\ell_2^2 + w^2}{12}$$

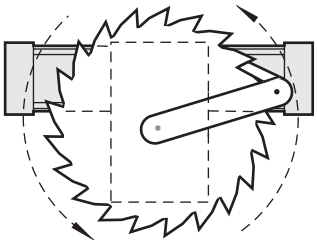


Thin Rod

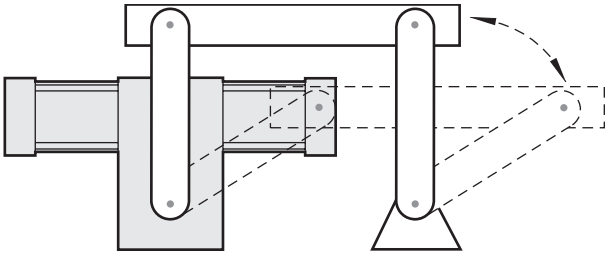
$$J = \frac{W_1}{g} \times \frac{\ell_1^2}{3} + \frac{W_2}{g} \times \frac{\ell_2^2}{3}$$



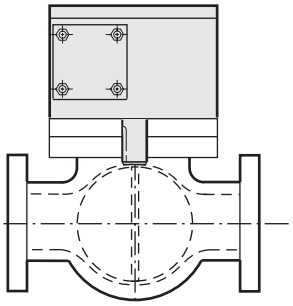
Screw Clamping



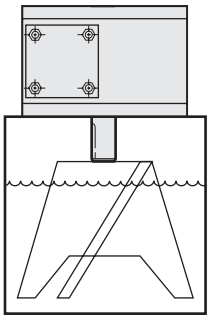
Rotation



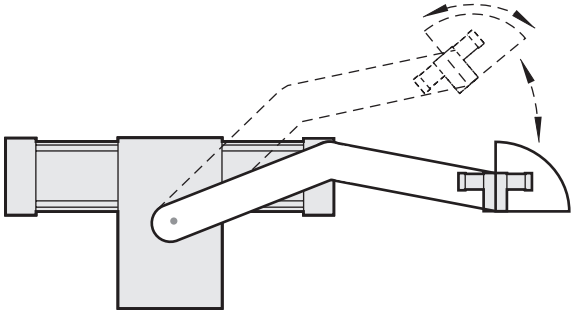
Automation Transfer



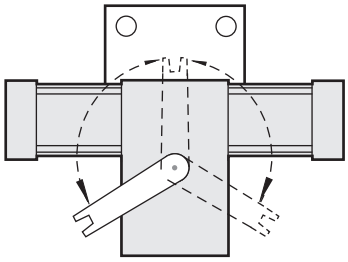
Valve Turning



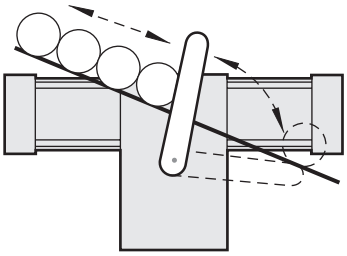
Mixer



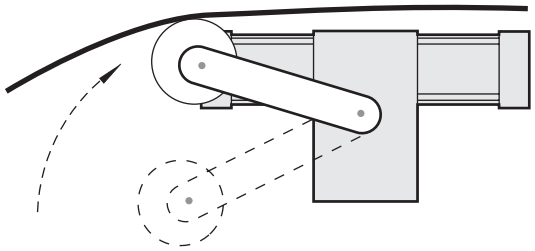
Material Handling



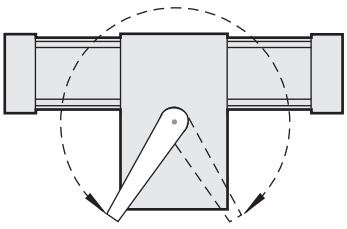
Load and Unload Machine



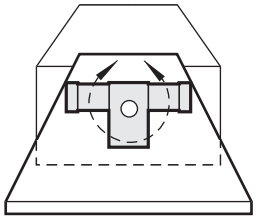
Intermittent Feed



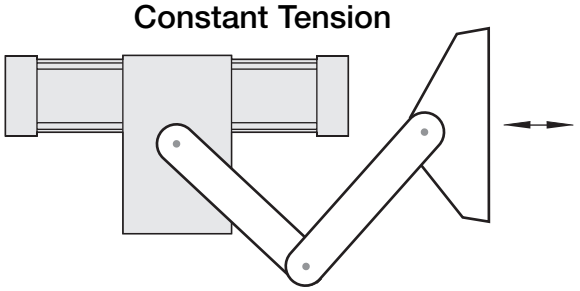
Constant Tension



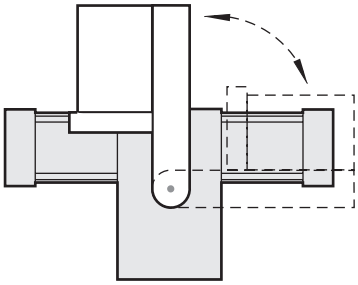
Turn or Oscillate



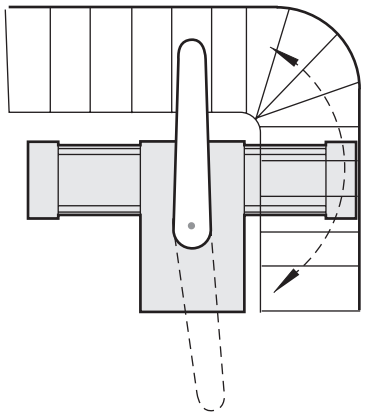
Turnover or Dumping



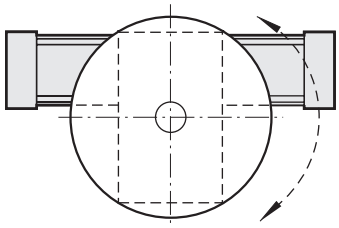
Toggle Push or Clamp



Lift or Rotate



Conveyor Turn or Stop



Index or Position