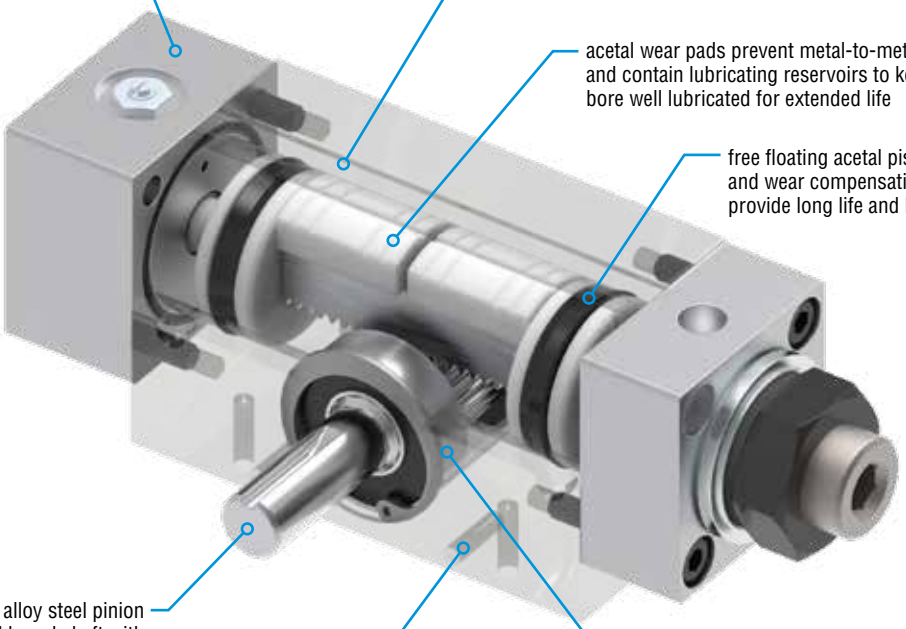
RL

Major Benefits

- Low cost
- OEM style rotaries
- High axial and radial bearing load
- High torque/package size



ORDERING DATA: Series RL Rotary Actuators

TO ORDER SPECIFY:
Product, Series, Type,
Design No., Bore Size,
Angle of Rotation, and Options.

PRODUCT
R - Rotary Actuator

TYPE
S - 150 psi [10 bar] Air Max.

BORE SIZE
12 mm
16 mm
20 mm
25 mm
32 mm
40 mm
50 mm
63 mm

SHOCK ABSORBER
NB - Shock both directions
NC - Shock counterclockwise
NW - Shock clockwise
GS - Shock ready both directions
GT - Shock ready counterclockwise
GU - Shock ready clockwise
Shock absorber options not available on 12 mm, 16 mm, and 20 mm units.

SWITCH READY
E - Magnets for Series 5360 Solid State Hall Effect Switches
I - Magnets for Series 5360 Magnetoresistive Switches
M - Magnets for Series 5360 Reed Switches
Switches must be ordered separately. See notes 2, 3, 4, and option page.

MISCELLANEOUS
GX - Mounting holes in Positions 3 & 4 (Positions 2 & 3 standard)
Q13 - Double shaft extension
U4 - Port Position 2
U6 - Port Position 3
U8 - Port Position 4
-U options apply only to caps with angle adjustment or shock absorber options. Port Positions on all other caps are in Position 5.

R	L	S	1	40	x	180	-	NC	-	BW	-	AW	-	E	-	Q13

SERIES
L - Medium Duty

DESIGN NO.
1 - Imperial
5 - Metric

ANGLE OF ROTATION
45°, 90°, 135°, 180°, 225°, 270°
See Note 6.

CUSHION CONTROL
DB - Cushion both directions
DC - Cushion counterclockwise
DW - Cushion clockwise
BB - Shock Pad both directions
BC - Shock Pad counterclockwise
BW - Shock Pad clockwise
Cushions and shock pads not available on same end of actuator. Shock pad options not available on 12 mm units.

ANGLE ADJUSTMENT
AB - 45° Angle Adjustment both directions
AC - 45° Angle Adjustment counterclockwise
AW - 45° Angle Adjustment clockwise

NOTES:
1) Shock pad and/or angle adjustment options not available in the same direction with cushion or shock absorber options.
2) -E option not available on 12 mm and 16 mm units.
3) -M option not available on 12 mm units. A minimum of 90° of rotation required for one switch, and 135° of rotation for two switches on 16 mm units.
4) -I option a minimum of 90° of rotation required on 12 mm and 16 mm bores.
5) For keyless hub adaptor kits, see accessories page.
6) 45°, 135°, and 225° rotations are not available on 12 mm or 16 mm units.

SHOCK ABSORBERS

BORE SIZE	PHD SHOCK ABSORBER NO.
25 mm	60335-04
32 mm	60335-05
40 mm	60335-06
50 mm	60335-06
63 mm	60335-07

SERIES 5360 MAGNETORESISTIVE SWITCHES

PART NO.	COLOR	DESCRIPTION
53605-1-02	Black	NPN 6-24 VDC, 2 meter cable
53606-1-02	Orange	PNP 6-24 VDC, 2 meter cable
53625-1	Black	NPN 6-24 VDC, Quick Connect
53626-1	Orange	PNP 6-24 VDC, Quick Connect

⚠ Options may affect unit length. See dimensional pages and option information details.

SERIES 5360 HALL EFFECT SWITCHES

PART NO.	COLOR	DESCRIPTION
53603-1-02	Yellow	NPN (Sink) 4.5-24 VDC, 2 meter cable
53604-1-02	Red	PNP (Source) 4.5-24 VDC, 2 meter cable
53623-1	Yellow	NPN (Sink) 4.5-24 VDC, Quick Connect
53624-1	Red	PNP (Source) 4.5-24 VDC, Quick Connect

SERIES 5360 REED SWITCHES

PART NO.	COLOR	DESCRIPTION
53602-2-02	White	Sink or Source Type 4.5-24 VDC, 2 meter cable
53609-2-02	Green	AC Type 110-120 VAC with Current Limit, 2 meter cable
53622-2	White	Sink or Source Type VDC, Quick Connect
53629-2	Green	AC Type 110-120 VAC, Quick Connect with Current Limit

NOTE: See Switches and Sensors catalog for additional switch information and complete specification. Switches must be ordered separately.

CAD & Sizing Assistance

Use PHD's free online Product Sizing and CAD Configurator at **phdinc.com/myphd**

SPECIFICATIONS	SERIES RL
OPERATING PRESSURE	20 to 150 psi max [1.4 to 10 bar]
OPERATING TEMPERATURE	-20° to 180°F [-29° to 82°C]
RATED LIFE	5 million cycles
ROTATIONAL TOLERANCE	Nominal rotation +15° to 0°
BACKLASH AT END OF ROTATION	1° 30' (12/16 mm), 1° 0' (20/25 mm) 0° 45' (32/40 mm), 0° 30' (50/63 mm)
LUBRICATION	Factory lubricated for rated life
MAINTENANCE	Field repairable

SIZE	ROTATION	BASE WEIGHT		BORE DIAMETER		DISPLACEMENT VOLUME/deg		THEORETICAL TORQUE OUTPUT		ROTATIONAL VELOCITY MAX	MAX AXIAL BEARING LOAD		MAX RADIAL BEARING LOAD		DISTANCE BETWEEN BEARINGS	
		lb	kg	in	mm	in^3/deg	mm^3/deg	in-lb/psi	Nm/bar	deg/sec	lb	N	lb	N	in	mm
12	90°	0.3	0.13	0.472	12	0.0005	8.19	0.029	0.05	180°/0.03	26	115	165	734	0.65	16.6
	180°	0.4	0.18													
	270°	0.4	0.18													
16	90°	0.4	0.18	0.630	16	0.001	16.39	0.062	0.10	180°/0.03	39	173	230	1023	0.73	18.6
	180°	0.5	0.22													
	270°	0.6	0.27													
20	45°/90°	0.7	0.32	0.787	20	0.002	32.77	0.122	0.20	180°/0.05	39	173	230	1023	0.89	22.6
	135°/180°	0.8	0.36													
	225°/270°	0.9	0.41													
25	45°/90°	1.1	0.50	0.984	25	0.004	65.55	0.228	0.37	180°/0.05	110	489	320	1423	1.11	28.1
	135°/180°	1.2	0.54													
	225°/270°	1.4	0.64													
32	45°/90°	1.7	0.77	1.260	32	0.008	131.10	0.468	0.77	180°/0.05	160	711	390	1734	1.28	32.6
	135°/180°	2.0	0.91													
	225°/270°	2.3	1.04													
40	45°/90°	2.6	1.17	1.575	40	0.017	278.58	0.974	1.60	180°/0.06	184	818	420	1868	1.60	40.6
	135°/180°	3.3	1.49													
	225°/270°	4.3	1.95													
50	45°/90°	5.2	2.36	1.969	50	0.032	524.39	1.826	2.99	180°/0.075	285	1267	660	2935	1.93	49.1
	135°/180°	6.0	2.72													
	225°/270°	6.9	3.13													
63	45°/90°	9.2	4.17	2.480	63	0.063	1032.38	3.624	5.94	180°/0.075	450	2001	925	4114	2.52	64.1
	135°/180°	10.5	4.76													
	225°/270°	12.3	5.57													

OPTION WEIGHT TABLE

BORE SIZE	TYPE OF UNIT	NOMINAL ROTATION					
		45° or 90°		135° or 180°		225° or 270°	
		lb	kg	lb	kg	lb	kg
12 mm	CUSHION	0.4	0.18	0.4	0.18	0.5	0.22
	ANGLE ADJUSTMENT	0.4	0.18	0.5	0.22	0.5	0.22
16 mm	CUSHION	0.5	0.23	0.6	0.27	0.7	0.32
	ANGLE ADJUSTMENT	0.6	0.27	0.7	0.32	0.7	0.32
20 mm	CUSHION	0.9	0.41	0.9	0.41	1.0	0.45
	ANGLE ADJUSTMENT	0.9	0.41	1.0	0.45	1.1	0.50
25 mm	CUSHION	1.4	0.64	1.5	0.68	1.6	0.70
	ANGLE ADJUSTMENT	1.4	0.64	1.5	0.68	1.7	0.80
32 mm	CUSHION	2.0	0.91	2.3	1.04	2.7	1.22
	ANGLE ADJUSTMENT	2.4	1.07	2.7	1.22	3.0	1.36
40 mm	CUSHION	3.2	1.45	4.0	1.81	4.9	2.22
	ANGLE ADJUSTMENT	3.6	1.63	4.3	1.95	5.3	2.40
50 mm	CUSHION	6.0	2.72	6.7	3.04	7.7	3.49
	ANGLE ADJUSTMENT	6.8	3.08	7.6	3.45	8.5	3.85
63 mm	CUSHION	10.4	4.71	11.8	5.35	13.5	6.12
	ANGLE ADJUSTMENT	10.6	4.81	12.0	5.44	13.7	6.21

NOTE: Units with shock pad options are the same approximate weight as plain units. Units with shock absorber options are the same approximate weight as units with angle adjustment.

To select the appropriate RL rotary actuator, it is crucial to consider several factors including bearing capacity, torque requirements and stopping capacity of the actuator. The bearing capacities are listed on previous page. To determine the required torque to rotate the load in a given time, the rotational mass moments of inertia, gravity, time and acceleration must be taken into account. To stop an actuator, all of the same required information for torque is needed plus kinetic energy. Follow the steps below to select the appropriate RL actuator.

1) Review previous page to make sure RL rotary actuator bearings can withstand axial and radial bearing loads.

2) Determine the torque requirements of the actuator.

   a) Determine Mass Moment of Inertia.
   Select the illustration from the application types on the following page that most resembles your specific application. Several separate calculations may be necessary to fully describe your application. Using the appropriate application equation, calculate the mass moment of inertia for each type of illustration. The total mass moment of inertia will be the sum of the individual calculations.

   b) Determine the necessary acceleration.

   Acceleration (α) = (2 x (Rotation angle in radians)) / (Time of Rotation in Seconds)^2

   Acceleration (α) = (0.035 x (Rotation angle in degrees)) / (Time of Rotation in Seconds)^2

   c) Calculate the required torque.
   Select the illustration from the application types on the following page that most resembles your specific application. Several separate calculations may be necessary to fully describe your application. Using the appropriate application equation, calculate the mass moment of inertia for each type of illustration. The total torque will be the sum of the individual calculations. **NOTE:** Torque calculations are theoretical, an appropriate safety factor should be considered. PHD recommends a minimum safety factor of 2 to account for friction loss, airline and valve size, and attached accessories.

3) Determine the stopping capacity of the actuator by using the equation given below.

KINETIC ENERGY BASIC EQUATIONS

EQUATION A

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

a) Determine the rotational velocity by using equation A.

ROTATIONAL VELOCITY EQUATION

Estimated Peak Velocity (rad/sec)
Uniformly accelerated from rest

ω = rad / sec =
(0.035 x Degrees of Rotation) / Time of Rotation in seconds

b) Using Jm from step 2a and velocity from step 3a, calculate the kinetic energy of the application.

c) Use the KE Energy Table below to select appropriate RL actuator.

KINETIC ENERGY TABLE

BORE SIZE	KE MAX. PLAIN UNIT		KE MAX. WITH SHOCK PAD		KE MAX. WITH CUSHION		KE MAX. WITH SHOCK ABSORBER	
	in-lb	Nm	in-lb	Nm	in-lb	Nm	in-lb	Nm
12 mm	0.07	0.008	—	—	0.35	0.040	—	—
16 mm	0.09	0.011	0.26	0.03	0.53	0.060	—	—
20 mm	0.16	0.018	0.30	0.03	0.60	0.068	—	—
25 mm	0.22	0.025	0.39	0.04	0.79	0.089	6.00	0.678
32 mm	0.48	0.054	0.83	0.09	1.66	0.188	12.00	1.356
40 mm	1.03	0.116	1.80	0.20	3.60	0.406	30.00	3.390
50 mm	1.78	0.202	3.12	0.35	6.25	0.706	48.00	5.423
63 mm	2.63	0.297	4.60	0.52	9.21	1.040	84.00	9.491

IMPERIAL UNITS:

Jm = Rotational Mass Moment of Inertia (in-lb-sec^2) (Dependent on physical size of object and weight)
g = Gravitational Constant = 386.4 in/sec^2 | F_g = Weight of Load (lb) | k = Radius of Gyration (in)
T = Torque required to rotate load (in-lbs) | α = Acceleration (rad/sec^2) | t = time (sec)
SF = Safety Factor

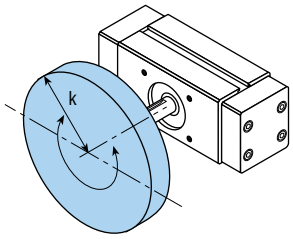
METRIC UNITS:

Jm = Rotational Mass Moment of Inertia (N-m-sec^2) (Dependent on physical size of object and weight)
g = Gravitational Constant = 9.81 m/sec^2 | F_g = Weight of Load (N) | k = Radius of Gyration (m)
T = Torque required to rotate load (N-m) | α = Acceleration (rad/sec^2) | t = time (sec)
M = Mass = F_g / g (kg) | SF = Safety Factor

BALANCED LOADS

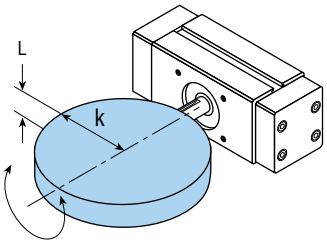
$T = Jm \times \alpha \times SF$

Disk
Mounted on center



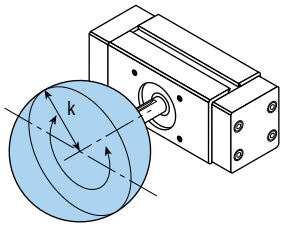
$$Jm = \frac{F_g}{g} \times \frac{k^2}{2}$$

Disk
End mounted on center



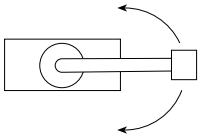
$$Jm = \frac{F_g}{g} \times \frac{1}{4} \times \left(\frac{L^2}{3} + k^2\right)$$

Solid Sphere
Mounted on center

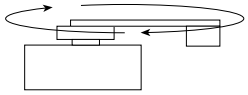


$$Jm = \frac{2}{5} \times \frac{F_g}{g} \times k^2$$

LOAD ORIENTATION

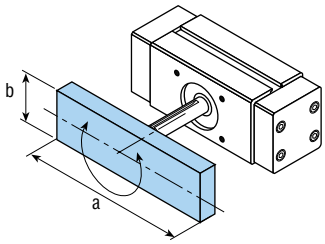


T_g = Rotating Vertically (with gravity)



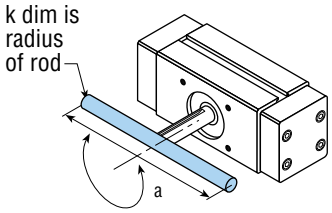
T = Rotating Horizontally (without gravity)

Rectangular Plate
Mounted on center



$$Jm = \frac{F_g}{g} \times \frac{a^2 + b^2}{12}$$

Rod
Mounted on center

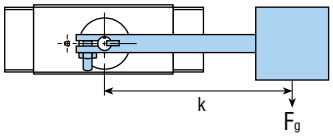


$$Jm = \frac{F_g}{g} \times \frac{a^2 + 3k^2}{12}$$

UNBALANCED LOADS

$T_g = [(Jm \times \alpha) + (F_g \times k)] \times SF$
$T = Jm \times \alpha \times SF$

Point Load

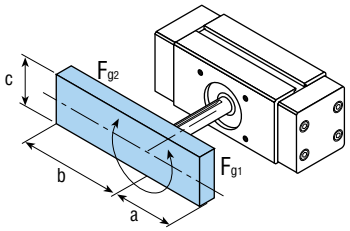


$$Jm = \frac{F_g}{g} \times k^2$$

UNBALANCED LOADS

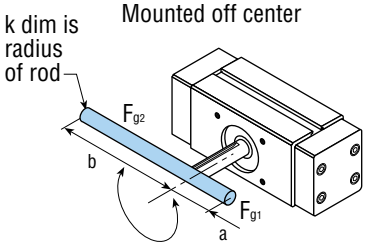
$T_g = [(Jm \times \alpha) + [(F_{g2} - F_{g1}) \times (a + (\frac{b-a}{2}))]] \times SF$
$T = Jm \times \alpha \times SF$

Rectangular Plate
Mounted off center



$$Jm = \frac{F_{g1}}{g} \times \frac{4a^2 + c^2}{12} + \frac{F_{g2}}{g} \times \frac{4b^2 + c^2}{12}$$

Rod
Mounted off center



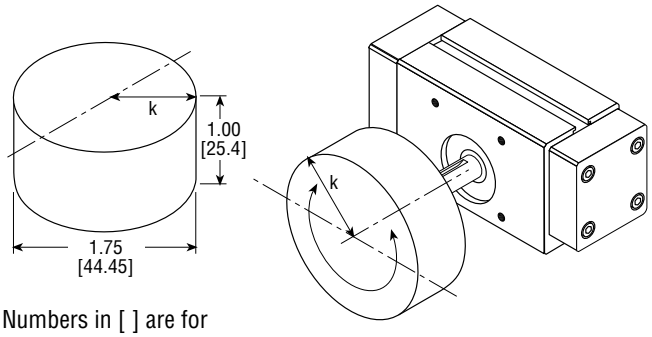
$$Jm = \left(\frac{F_{g1}}{g} \times \frac{(4a^2 + 3k^2)}{12}\right) + \left(\frac{F_{g2}}{g} \times \frac{(4b^2 + 3k^2)}{12}\right)$$

APPLICATION EXAMPLE A

Disk rotating about centerline of unit.

1) Determine load information:

	IMPERIAL	METRIC
ROTATION ANGLE / TIME	180° / 0.10 sec	180° / 0.10 sec
LOAD	Aluminum Disk	Aluminum Disk
WEIGHT	0.236 lb	1.05 N
MASS		0.107 Kg
PRESSURE	87 psi	6 bar
SAFETY FACTOR	2	2



Numbers in [ ] are for metric units and are in mm.

2) Determine torque requirement for the application:

a) Calculate Rotational Mass Moment of Inertia (Jm) using equations given on page 13.

IMPERIAL
$Jm = (F_g / g) \times (k^2 / 2)$
$Jm = (0.236\ lb / 386.4) \times ((0.875\ in)^2 / 2)$
$Jm = 0.000234\ in\text{-}lb\text{-}sec^2$

METRIC
$Jm = (F_g / g) \times (k^2 / 2)$
$Jm = (1.05\ N / 9.81) \times ((0.0222\ m)^2 / 2)$
$Jm = 2.64 \times 10^{-5}\ N\text{-}m\text{-}sec^2$

b) Determine required acceleration of the load:

$\alpha = 0.035 \times (\text{rotational angle (deg)}) / (\text{time of rotation (sec)}^2)$
$\alpha = 0.035 \times (180° / (0.1\ sec)^2) = 630\ rad/sec^2$

c) Calculate required torque:

IMPERIAL
$T = Jm \times \alpha \times SF$
$T = 0.000234 \times 630 \times 2 = 0.29\ in\text{-}lbs$

METRIC
$T = Jm \times \alpha \times 2$
$T = 2.64 \times 10^{-5} \times 630 \times 2 = 0.03\ N\text{-}m$

To select minimum actuator based on torque, calculate theoretical torque for 87 psi [6 bar] by using table on page 11.

3) Determine the stopping capacity of the actuator for the application:

a) Determine the estimated peak rotational velocity using Equation A on page 12.

$\omega = \text{rad / sec} = 0.035 \times (\text{rotation angle (deg)}) / (\text{rotational time (sec)})$
$\omega = 0.035 \times (180° / 0.1\ sec) = 63\ rad/sec$

b) Using Jm from step 2a and velocity from step 3a, determine KE of the system from the basic KE equation:

IMPERIAL
$KE = 1/2 \times Jm \times \omega^2$
$KE = 0.5 \times 0.000234 \times 63^2$
$KE = 0.464\ in\text{-}lbs$

METRIC
$KE = 1/2 \times Jm \times \omega^2$
$KE = 0.5 \times 2.64 \times 10^{-5} \times 63^2$
$KE = 0.052\ N\text{-}m$

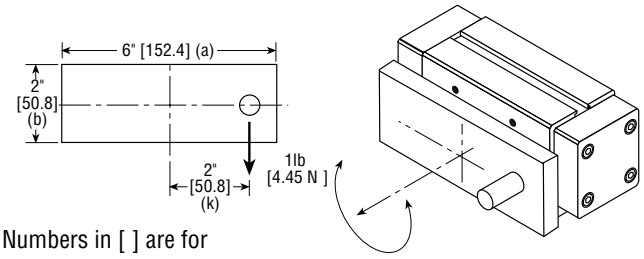
c) Use the KE Energy Table on page 12 to select the appropriate RL actuator. The following units satisfy the requirements. 32 mm plain, 32 mm with shock pads, and a 16, 20, or 25 mm with cushions.

APPLICATION EXAMPLE B

Combination of rectangular plate mounted on center and a point load mounted off center.

1) Determine load information:

	IMPERIAL	METRIC
ROTATION ANGLE / TIME	180° / 0.5 sec	180° / 0.5 sec
RECTANGULAR PLATE	Steel Plate	Steel Plate
WEIGHT	1.698 lb	7.55 N
MASS		0.77 Kg
POINT LOAD	1 lb (2" off center)	4.45 N (50.8 mm off center)
PRESSURE	87 psi	6 bar
SAFETY FACTOR	2	2



Numbers in [ ] are for metric units and are in mm.

2) Determine torque requirement for the application:

a) Calculate Rotational Mass Moment of Inertia (Jm) using equations given on page 13.

POINT LOAD

IMPERIAL
$Jm = (F_g / g) \times k^2$
$Jm = (1\ lb / 386.4) \times (2\ in)^2$
$Jm = 0.0104\ in\text{-}lb\text{-}sec^2$

METRIC
$Jm = (F_g / g) \times k^2$
$Jm = (4.45\ N / 9.81) \times (0.0508\ m)^2$
$Jm = 0.00117\ N\text{-}m\text{-}sec^2$

RECTANGULAR PLATE

IMPERIAL
$Jm = (F_g / g) \times ((a^2 + b^2) / 12)$
$Jm = (1.698 / 386.4) \times ((6^2 + 2^2) / 12)$
$Jm = 0.0146\ in\text{-}lb\text{-}sec^2$
Total Jm = 0.0146 + 0.0104 = $0.025\ in\text{-}lb\text{-}sec^2$

METRIC
$Jm = (F_g / g) \times ((a^2 + b^2) / 12)$
$Jm = (7.55 / 9.81) \times ((0.1524^2 + 0.0508^2) / 12)$
$Jm = 0.00165\ N\text{-}m\text{-}sec^2$
Total Jm = 0.00165 + 0.00117 = $0.00282\ N\text{-}m\text{-}sec^2$

b) Determine required acceleration of the load:

$\alpha = 0.035 \times (\text{rotational angle (deg)}) / (\text{time (sec)}^2)$
$\alpha = 0.035 \times (180° / (0.5\ sec)^2) = 25.2\ rad/sec^2$

c) Calculate required torque:

POINT LOAD

IMPERIAL
$T = ((Jm \times \alpha) + (F_g \times k)) \times 2$
$T = ((0.0140 \times 25.2) + (1 \times 2)) \times 2$
$T = 4.5\ in\text{-}lbs$

METRIC
$T = ((Jm \times \alpha) + (F_g \times k)) \times SF$
$T = ((0.00117 \times 25.2) + (4.45 \times 0.0508)) \times 2$
$T = 0.51\ N\text{-}m$

RECTANGULAR PLATE

IMPERIAL
$T = Jm \times \alpha \times SF$
$T = 0.0146 \times 25.2 \times 2 = 0.74\ in\text{-}lbs$
Total T = 4.5 + 0.74 = $5.24\ in\text{-}lbs$

METRIC
$T = Jm \times \alpha \times SF$
$T = 0.00166 \times 25.2 \times 2 = 0.084\ N\text{-}m$
Total T = 0.51 + 0.084 = $0.594\ N\text{-}m$

To select minimum actuator based on torque, calculate theoretical torque for 87 psi [6 bar] by using table on page 11.

3) Determine the stopping capacity of the actuator for the application:

a) Determine the estimated peak rotational velocity using Equation A on page 12.

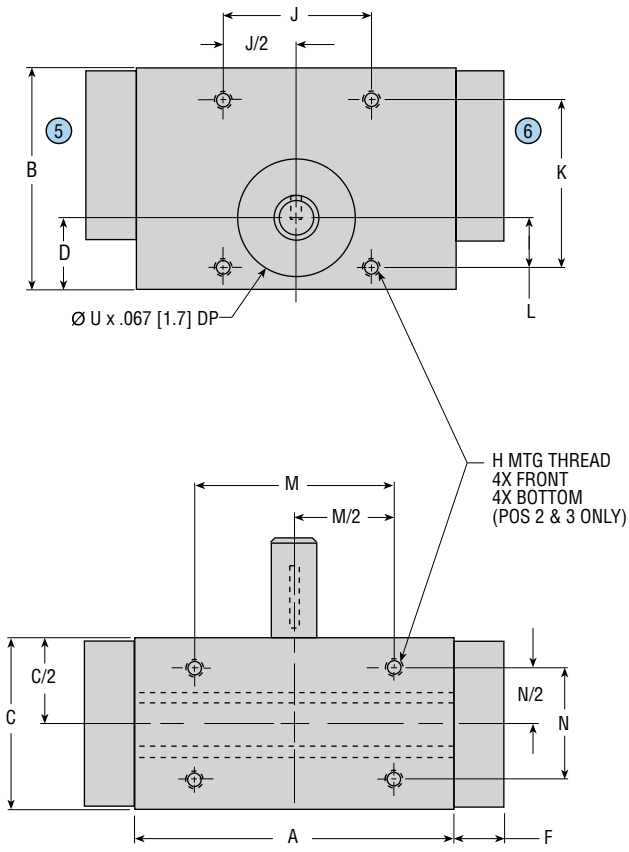
$\omega = 0.035 \times (\text{rotation angle (deg)}) / (\text{rotational time (sec)})$
$\omega = 0.035 \times (180° / 0.5\ sec) = 12.6\ rad/sec$

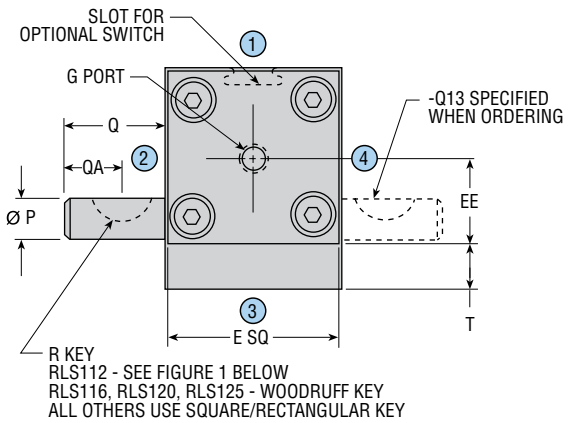
b) Using Jm from step 2a and velocity from step 3a, determine KE of the system from the basic KE equation:

IMPERIAL
$KE = 1/2 \times Jm \times \omega^2$
$KE = 0.5 \times 0.025 \times 12.6^2$
$KE = 1.98\ in\text{-}lbs$

METRIC
$KE = 1/2 \times Jm \times \omega^2$
$KE = 0.5 \times 0.00282 \times 12.6^2$
$KE = 0.224\ N\text{-}m$

c) Use the KE Energy Table on page 12 to select the appropriate RL actuator. The following units satisfy the requirements: 63 mm plain, 50 mm with shock pads, 40 mm with cushions, and a 25 mm with shock absorbers.





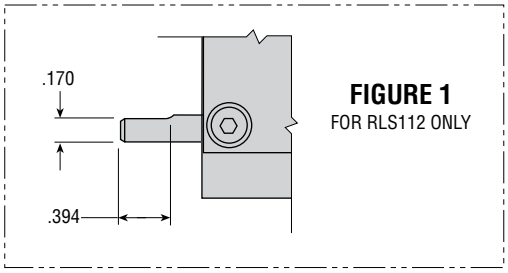


FIGURE 1
FOR RLS112 ONLY

NOTES:
1) CIRCLED NUMBERS INDICATE MOUNTING SURFACE POSITION
2) NUMBERS IN [ ] ARE FOR METRIC UNITS AND ARE IN mm
3) KEYWAY SHOWN AT MID-ROTATION POSITION

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All dimensions are reference only unless specifically toleranced.

BORE SIZE	NOMINAL ROTATION	A	B	C	D	E	EE	F	G PORT	H
12 mm	90°	2.060 [52.3]	1.201 [30.5]	1.024 [26.0]	0.447 [11.3]	0.964 [24.5]	0.482 [12.24]	0.374 [9.5]	10-32 THD [M5 x 0.8]	4-40 x 0.224 [M3 x 0.5 x 6.0]
	180°	2.588 [65.7]								
	270°	3.113 [79.1]								
16 mm	90°	2.466 [62.6]	1.378 [35.0]	1.142 [29.0]	0.539 [13.7]	1.082 [27.5]	0.541 [13.74]	0.374 [9.5]	10-32 THD [M5 x 0.8]	4-40 x 0.224 [M3 x 0.5 x 6.0]
	180°	3.094 [78.6]								
	270°	3.564 [90.5]								
20 mm	45° or 90°	2.858 [72.6]	1.634 [41.5]	1.300 [33.0]	0.532 [13.5]	1.260 [32.0]	0.630 [16.0]	0.374 [9.5]	10-32 THD [M5 x 0.8]	6-32 x 0.276 [M4 x 0.7 x 8.0]
	135° or 180°	3.251 [82.6]								
	225° or 270°	3.955 [100.5]								
25 mm	45° or 90°	3.501 [88.9]	1.811 [46.0]	1.556 [39.5]	0.623 [15.8]	1.516 [38.5]	0.758 [19.25]	0.473 [12.0]	1/8 NPT [1/8 BSP]	10-24 x 0.380 [M5 x 0.8 x 10.0]
	135° or 180°	3.972 [100.9]								
	225° or 270°	4.915 [124.8]								
32 mm	45° or 90°	3.730 [94.7]	2.244 [57.0]	1.772 [45.0]	0.788 [20.0]	1.732 [44.0]	0.866 [22.0]	0.473 [12.0]	1/8 NPT [1/8 BSP]	10-24 x 0.380 [M5 x 0.8 x 10.0]
	135° or 180°	4.711 [119.7]								
	225° or 270°	5.880 [149.3]								
40 mm	45° or 90°	4.638 [117.8]	2.579 [65.5]	2.126 [54.0]	0.866 [22.0]	2.086 [53.0]	1.043 [26.5]	0.473 [12.0]	1/8 NPT [1/8 BSP]	1/4-20 x 0.500 [M6 x 1.0 x 12.0]
	135° or 180°	5.930 [150.6]								
	225° or 270°	7.500 [190.0]								
50 mm	45° or 90°	5.295 [134.5]	3.248 [82.5]	2.540 [64.5]	1.004 [25.5]	2.480 [63.0]	1.240 [31.5]	0.650 [16.5]	1/4 NPT [1/4 BSP]	5/16-18 x 0.625 [M8 x 1.25 x 16.0]
	135° or 180°	6.858 [174.2]								
	225° or 270°	8.667 [220.1]								
63 mm	45° or 90°	6.535 [166.0]	3.858 [98.0]	3.168 [80.5]	1.279 [32.5]	2.972 [75.5]	1.486 [37.75]	0.650 [16.5]	1/4 NPT [1/4 BSP]	5/16-18 x 0.625 [M8 x 1.25 x 16.0]
	135° or 180°	8.504 [216.0]								
	225° or 270°	10.846 [275.5]								

BORE SIZE	J	K	L	M	N	P [h8]	Q	QA	R	T	U
12 mm	1.062 [27.0]	0.866 [22.0]	0.335 [8.5]	1.378 [35.0]	0.630 [16.0]	0.1875 [6.0]	0.630 [16.0]	—	SEE FIGURE 1 [2.0 SQ x 10.0]	0.233 [5.9]	0.7485 [19.0]
16 mm	1.142 [29.0]	1.004 [25.5]	0.373 [9.5]	1.536 [39.0]	0.650 [16.5]	0.2495 [8.0]	0.748 [19.0]	0.312 [7.92]	203 WOODRUFF [3.0 SQ x 14.0]	0.289 [7.3]	0.8666 [22.0]
20 mm	1.102 [28.0]	1.220 [31.0]	0.354 [9.0]	1.516 [38.5]	0.906 [23.0]	0.3125 [8.0]	0.748 [19.0]	0.437 [11.1]	204 WOODRUFF [3.0 SQ x 14.0]	0.349 [8.9]	0.8666 [22.0]
25 mm	1.378 [35.0]	1.397 [35.5]	0.443 [11.25]	1.968 [50.0]	1.182 [30.0]	0.3745 [10.0]	1.004 [25.5]	0.437 [11.1]	204 WOODRUFF [3.0 SQ x 16.0]	0.292 [7.4]	1.0241 [26.0]
32 mm	1.614 [41.0]	1.850 [47.0]	0.631 [16.0]	2.204 [56.0]	1.260 [32.0]	0.4995 [14.0]	1.260 [32.0]	—	1/8 SQ x 3/4 [5.0 SQ x 20.0]	0.488 [12.4]	1.2603 [32.0]
40 mm	2.028 [51.5]	2.146 [54.5]	0.650 [16.5]	2.874 [73.0]	1.534 [39.0]	0.6245 [16.0]	1.496 [38.0]	—	3/16 SQ x 1.00 [5.0 SQ x 25.0]	0.476 [12.1]	1.3785 [35.0]
50 mm	2.480 [63.0]	2.677 [68.0]	0.670 [17.0]	3.308 [84.0]	1.850 [47.0]	0.7495 [20.0]	1.752 [44.5]	—	3/16 SQ x 1-1/4 [6.0 SQ x 30.0]	0.725 [18.4]	1.6540 [42.0]
63 mm	2.716 [69.0]	3.248 [82.5]	0.945 [24.0]	3.544 [90.0]	2.204 [56.0]	0.9995 [30.0]	2.007 [51.0]	—	1/4 SQ x 1-3/8 [8.0 x 7.0 x 36.0 RECT]	0.849 [21.6]	2.1659 [55.0]

Numbers in [ ] are for metric units and are in mm.

CAD & Sizing Assistance

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All dimensions are reference only unless specifically toleranced.

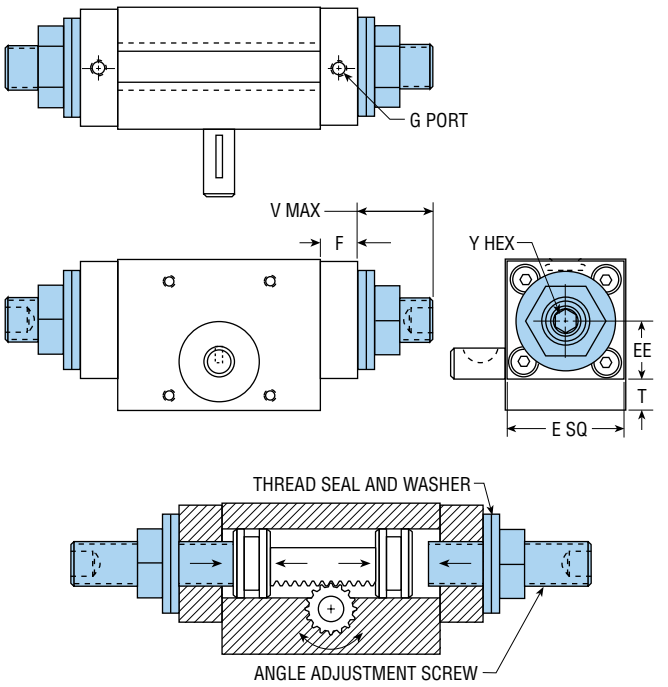
AB 45° ANGLE ADJUSTMENT BOTH DIRECTIONS

AC 45° ANGLE ADJUSTMENT COUNTERCLOCKWISE DIRECTION

AW 45° ANGLE ADJUSTMENT CLOCKWISE DIRECTION

Angle adjustment screws allow the nominal angle of rotation to be reduced by up to 45° from each end of rotation (-AC or -AW options). With adjustments at both ends of the unit, a total reduction of 90° (-AB option) can be achieved. Angle adjustment is available in either or both directions.

NOTE: Angle adjustment options are not available with cushion or shock absorber options in the same direction.



BORE SIZE	NOMINAL ROTATION	E	EE	F	G	T	V	Y	ANGLE ADJUSTMENT SEALING KIT
12 mm	45°, 90°, 180°, 270°	0.964 [24.5]	0.482 [12.24]	0.552 [14.0]	10-32 THD [M5 x 0.8]	0.233 [5.9]	0.511 [13.0]	4 mm	60334-01-x
16 mm	45°, 90°, 180°, 270°	1.082 [27.5]	0.541 [13.74]	0.552 [14.0]	10-32 THD [M5 x 0.8]	0.289 [7.3]	0.649 [16.5]	4 mm	60334-02-x
20 mm	45°, 90°, 180°, 270°	1.260 [32.0]	0.630 [16.0]	0.552 [14.0]	10-32 THD [M5 x 0.8]	0.349 [8.9]	0.747 [19.0]	6 mm	60334-03-x
25 mm	45°, 90°, 180°, 270°	1.516 [38.5]	0.758 [19.25]	0.827 [21.0]	1/8 NPT [1/8 BSP]	0.292 [7.4]	0.767 [19.5]	6 mm	60334-04-x
32 mm	45°, 90°, 180°, 270°	1.732 [44.0]	0.866 [22.0]	0.827 [21.0]	1/8 NPT [1/8 BSP]	0.488 [12.4]	0.984 [25.0]	8 mm	60334-05-x
40 mm	45°, 90°, 180°, 270°	2.086 [53.0]	1.043 [26.5]	0.984 [25.0]	1/8 NPT [1/8 BSP]	0.476 [12.1]	1.421 [36.1]	10 mm	60334-06-x
50 mm	45°, 90°, 180°, 270°	2.480 [63.0]	1.240 [31.5]	1.024 [26.0]	1/4 NPT [1/4 BSP]	0.725 [18.4]	1.378 [35.0]	10 mm	60334-06-x
63 mm	45°, 90°, 180°, 270°	2.972 [75.5]	1.486 [37.75]	1.024 [26.0]	1/4 NPT [1/4 BSP]	0.849 [21.6]	1.378 [35.0]	10 mm	60334-06-x

Numbers in [ ] are for metric units and are in mm.

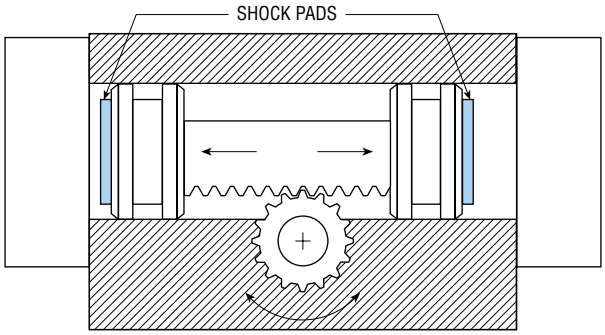
BB SHOCK PAD INSTALLED BOTH DIRECTIONS

BC SHOCK PAD INSTALLED COUNTERCLOCKWISE DIRECTION

BW SHOCK PAD INSTALLED CLOCKWISE DIRECTION

Polyurethane shock pads for noise reduction and absorption of shock at ends of rotation are available on each end of Series RL Rotary Actuators. Reduction of shock permits higher piston velocities for shorter cycle times. Noise reduction is beneficial for the working environment. See page 12 for information on unit stopping capacity.

NOTE: Shock pad options are not available on 12 mm units, or with shock absorber or cushion options in the same direction.



All dimensions are reference only unless specifically toleranced.

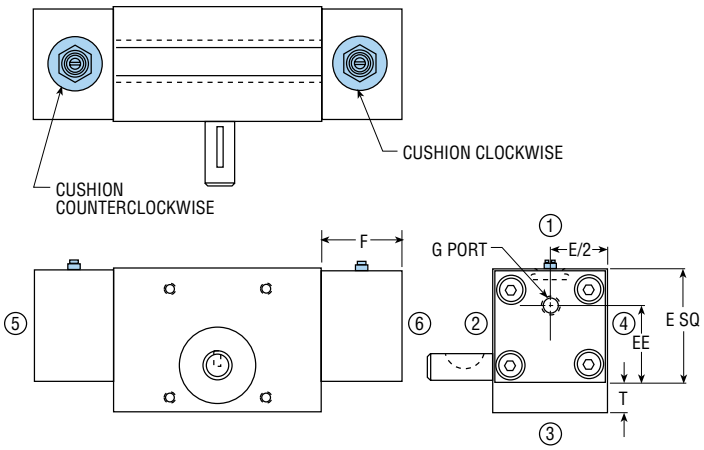
DB CUSHION BOTH DIRECTIONS

DC CUSHION COUNTERCLOCKWISE DIRECTION

DW CUSHION CLOCKWISE DIRECTION

PHD Cushions allow smooth deceleration at the end of rotation. When a cushion is activated, the remaining volume of air in the exhaust side of the actuator is expelled through an adjustable needle valve, controlling the rate of deceleration of the pinion shaft. The effective cushion length is approximately 40° at the end of full nominal rotation. See page 12 for information on unit stopping capacity.

Cushion performance will not be realized on units of 45° or less due to 40° of effective cushion length.



NOTE: Cushion options are not available with angle adjustment, shock absorber, or shock pad options in the same direction.

BORE SIZE	NOMINAL ROTATION	E	EE	F	G	T
12 mm	45°, 90°, 135°, 180°, 225°, 270°	0.964 [24.5]	0.226 [5.75]	0.728 [18.5]	10-32 THD [M5 x 0.8]	0.233 [5.9]
16 mm	45°, 90°, 135°, 180°, 225°, 270°	1.082 [27.5]	0.728 [18.5]	0.827 [21.0]	10-32 THD [M5 x 0.8]	0.289 [7.3]
20 mm	45°, 90°, 135°, 180°, 225°, 270°	1.260 [32.0]	0.856 [21.75]	0.866 [22.0]	10-32 THD [M5 x 0.8]	0.349 [8.9]
25 mm	45°, 90°, 135°, 180°, 225°, 270°	1.516 [38.5]	1.043 [26.5]	1.004 [25.5]	1/8 NPT [1/8 BSP]	0.292 [7.4]
32 mm	45°, 90°, 135°, 180°, 225°, 270°	1.732 [44.0]	1.161 [29.5]	1.063 [27.0]	1/8 NPT [1/8 BSP]	0.488 [12.4]
40 mm	45°, 90°, 135°, 180°, 225°, 270°	2.086 [53.0]	1.457 [37.0]	1.142 [29.0]	1/8 NPT [1/8 BSP]	0.476 [12.1]
50 mm	45°, 90°, 135°, 180°, 225°, 270°	2.480 [63.0]	1.752 [44.5]	1.260 [32.0]	1/4 NPT [1/4 BSP]	0.725 [18.4]
63 mm	45°, 90°, 135°, 180°, 225°, 270°	2.972 [75.5]	1.998 [50.75]	1.260 [32.0]	1/4 NPT [1/4 BSP]	0.849 [21.6]

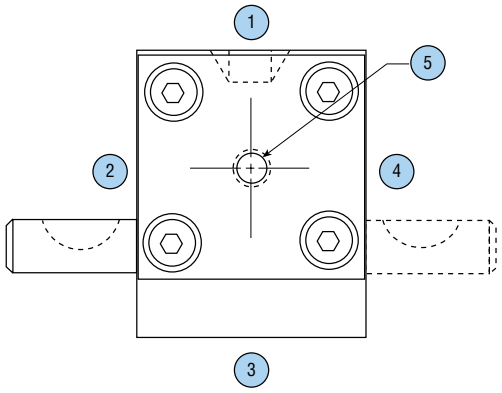
Numbers in [ ] are for metric units and are in mm.

U4 PORT POSITION 2

U6 PORT POSITION 3

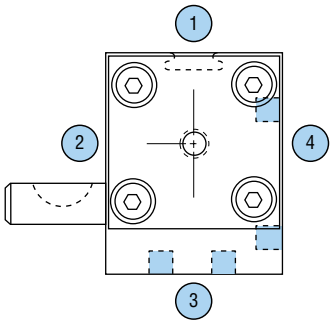
U8 PORT POSITION 4

Port positions on units with angle adjustment or shock absorber options are provided with a standard port in position 1. The port position may be rotated by specifying the desired option.



GX MOUNTING HOLES IN POSITIONS 3 & 4

This option provides mounting holes on the back side (position 4) and the bottom side (position 3). Standard units are supplied with mounting holes on the front side (position 2) and the bottom side (position 3). The mounting pattern for this option is identical to the pattern shown in the dimensions.



All dimensions are reference only unless specifically toleranced.

PHD Series 5360 Hall Effect, Reed, and Magnetoresistive Switches are designed specifically to provide an input signal to various types of programmable controllers of logic systems. **See Switches and Sensors catalog for information on the Series 5360 Switches.**

E MAGNETS FOR PHD SOLID STATE HALL EFFECT SWITCHES

This option equips the rotary actuator with magnets on the rack for use with PHD Series 5360 Hall Effect Switches. These switches mount easily to the actuator using the "T" slot in the top of the body. Not available on 12 mm and 16 mm units.

SERIES 5360 HALL EFFECT SWITCHES

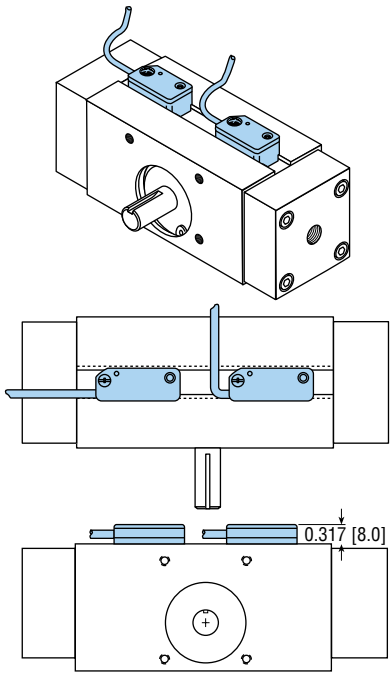
PART NO.	COLOR	DESCRIPTION
53603-1-02	Yellow	NPN (Sink) 4.5-24 VDC, 2 meter cable
53604-1-02	Red	PNP (Source) 4.5-24 VDC, 2 meter cable
53623-1	Yellow	NPN (Sink) 4.5-24 VDC, Quick Connect
53624-1	Red	PNP (Source) 4.5-24 VDC, Quick Connect

M MAGNETS FOR PHD REED SWITCHES

This option equips the rotary actuator with magnets on the rack for use with PHD Series 5360 Reed Switches. These switches mount easily to the actuator using the "T" slot in the top of the body. Not available on 12 mm units. For 16 mm bore units, minimum sensing rotation of 90° for one switch, and 135° for two switches is required.

SERIES 5360 REED SWITCHES

PART NO.	COLOR	DESCRIPTION
53602-2-02	White	Sink or Source Type 4.5-24 VDC, 2 meter cable
53609-2-02	Green	AC Type 110-120 VAC with Current Limit, 2 meter cable
53622-2	White	Sink or Source Type VDC, Quick Connect
53629-2	Green	AC Type 110-120 VAC, Quick Connect with Current Limit



I MAGNETS FOR PHD SOLID STATE MAGNETORESISTIVE SWITCHES

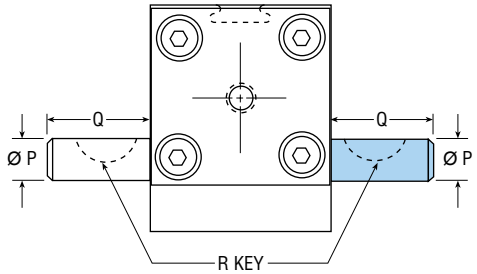
This option equips the rotary actuator with magnets on the rack for use with PHD Magnetoresistive Switches. These switches mount easily to the actuator using the "T" slot in the top of the body. Minimum sensing rotation of 90° for 12 mm and 16 mm units.

SERIES 5360 MAGNETORESISTIVE SWITCHES

PART NO.	COLOR	DESCRIPTION
53605-1-02	Black	NPN 6-24 VDC, 2 meter cable
53606-1-02	Orange	PNP 6-24 VDC, 2 meter cable
53625-1	Black	NPN 6-24 VDC, Quick Connect
53626-1	Orange	PNP 6-24 VDC, Quick Connect

Q13 DOUBLE SHAFT EXTENSION

This option provides a shaft extension out the front side (position 2) and the back side (position 4) of the actuator. This double shaft extension can be used for mounting tooling, fixturing, or for tripping external proximity switches. The one-piece pinion construction provides the same bearing load capacities for both front and rear shaft extensions.



BORE SIZE	P [h8]	Q	R
12 mm	0.1875 [6.0]	0.630 [16.0]	SEE FIGURE 1, PAGE 16 [2.0 SQ x 10.0]
16 mm	0.2495 [8.0]	0.748 [19.0]	203 WOODRUFF [3.0 SQ x 14.0]
20 mm	0.3125 [8.0]	0.748 [19.0]	204 WOODRUFF [3.0 SQ x 14.0]
25 mm	0.3745 [10.0]	1.004 [25.5]	204 WOODRUFF [3.0 SQ x 16.0]
32 mm	0.4995 [14.0]	1.260 [32.0]	1/8 SQ x 3/4 [5.0 SQ x 20.0]
40 mm	0.6245 [16.0]	1.496 [38.0]	3/16 SQ x 1.00 [5.0 SQ x 25.0]
50 mm	0.7495 [20.0]	1.752 [44.5]	3/16 SQ x 1-1/4 [6.0 SQ x 30.0]
63 mm	0.9995 [30.0]	2.007 [51.0]	1/4 SQ x 1-3/8 [8.0 x 7.0 x 36.0 RECT]

Numbers in [ ] are for metric units and are in mm.

All dimensions are reference only unless specifically toleranced.

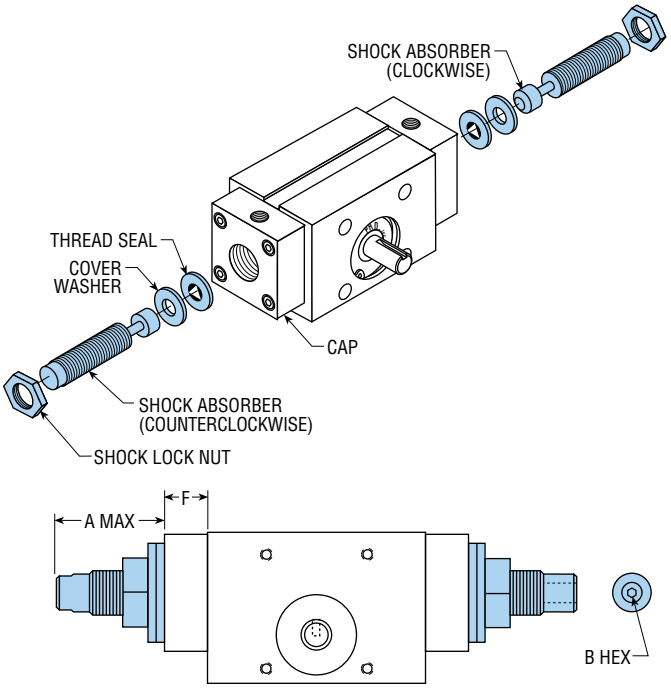
NB SHOCK ABSORBER INSTALLED BOTH DIRECTIONS

NC SHOCK ABSORBER INSTALLED COUNTERCLOCKWISE DIRECTION

NW SHOCK ABSORBER INSTALLED CLOCKWISE DIRECTION

Hydraulic shock absorbers provide optimum control of deceleration and maximum load stopping capacity. The -NB, -NC, and -NW options equip the rotary actuator with a hydraulic shock absorber installed in the cap(s). See page 12 for details of stopping capacity with built-in shock absorbers. Shock absorbers are nominally effective for 45° of rotation each direction.

NOTE: The shock absorber also provides the rotation adjustment. Shock absorber options are not available on 12 mm, 16 mm, or 20 mm units or with angle adjustment, cushion, or shock pad options in the same direction.



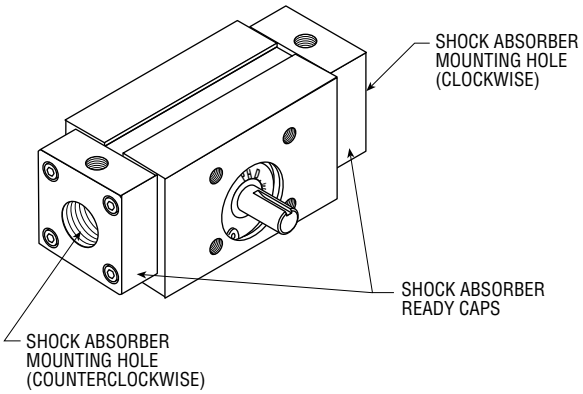
GS SHOCK ABSORBER READY BOTH DIRECTIONS

GT SHOCK ABSORBER READY COUNTERCLOCKWISE DIRECTION

GU SHOCK ABSORBER READY CLOCKWISE DIRECTION

The -GS, -GT, and -GU options should only be ordered if the shock absorber(s) is to be supplied separately from the rotary actuator. These options make provisions for the installation of hydraulic shock absorbers but do not include the shock absorber units. **They include the shock sealing kit for each direction ordered.** See page 12 for details of stopping capacity with built-in shock absorbers.

NOTE: The shock absorber also provides rotation adjustment. Shock absorbers **must** be installed in the rotary actuator body prior to operating the unit. Operation without shock absorbers can damage the actuator and void the warranty. Only shock absorbers specified by PHD should be used in Series RL Rotary Actuators. The use of any other shock absorbers will adversely affect actuator performance and service life.



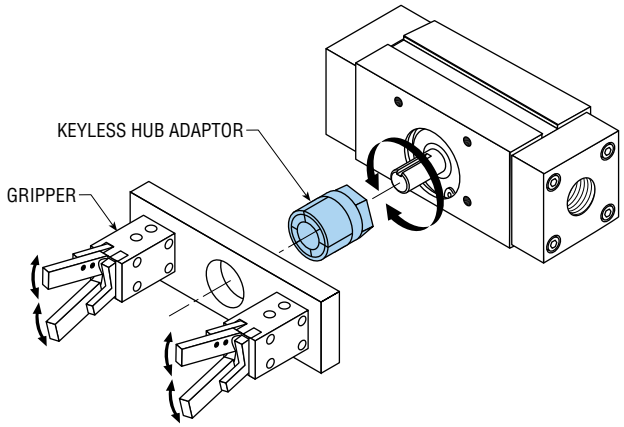
SHOCK ABSORBER SPECIFICATIONS

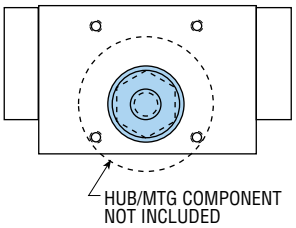
BORE SIZE	PHD SHOCK ABSORBER NUMBER	THREAD TYPE	STROKE		SHOCK ABSORBER WEIGHT		KINETIC ENERGY MAX. WITH SHOCK ABSORBER		A MAX.		B HEX		F		SHOCK ABSORBER SEALING KIT
			in	mm	lb	kg	in-lb	Nm	in	mm	in	mm	in	mm	
25 mm	60335-04	9/16-18	0.19	4.83	0.12	0.05	6.00	0.678	2.35	59.7	0.25	6.4	0.827	21.0	60334-04-x
32 mm	60335-05	3/4-16	0.25	6.35	0.34	0.15	12.00	1.356	2.75	69.6	0.31	7.9	0.827	21.0	60334-05-x
40 mm	60335-06	1-12	0.29	7.37	0.57	0.26	30.00	3.390	3.81	96.8	0.38	9.5	0.984	25.0	60334-06-x
50 mm	60335-06	1-12	0.29	7.37	0.57	0.26	48.00	5.423	3.77	95.8	0.38	9.5	1.024	26.0	60334-06-x
63 mm	60335-07	1-12	0.37	9.40	0.57	0.26	84.00	9.491	3.76	95.4	0.38	9.5	1.024	26.0	60334-06-x

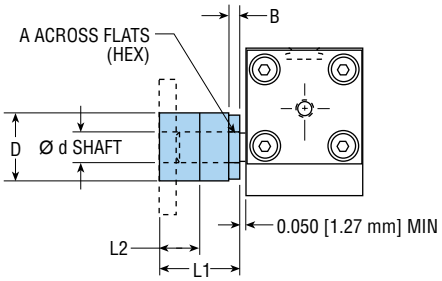
All dimensions are reference only unless specifically toleranced.

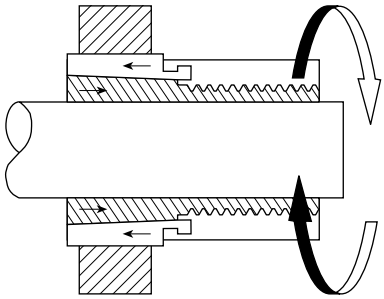
KEYLESS HUB ADAPTOR KIT

This kit provides an output hub for simple attachment of tooling or other PHD actuators to the Series RL Rotary Actuators. The PHD Keyless Hub Adaptor can be precisely adjusted to any angular and axial position on the rotary actuator shaft for maximum application versatility.









IMPERIAL UNIT	TRANTORQUE PART NO.	PHD PART NO.	d	D	D	L1	L2	B	A	MAX. TRANSMISSIBLE TORQUE	MAX. TRANSMISSIBLE THRUST	WEIGHT	INSTALLATION TORQUE ON NUT
			in	in	TOL.	in	in	in	in	in-lb	lb	oz	in-lb
RLS112	6202103	60264-01	0.188	0.625	±0.0015	0.750	0.375	0.125	0.500	100	700	0.50	125
RLS116	6202105	60264-02	0.250	0.625	±0.0015	0.750	0.375	0.125	0.500	150	790	0.50	125
RLS120	6202107	60264-03	0.313	0.750	±0.0015	0.875	0.438	0.125	0.625	200	890	1.0	150
RLS125	6202109	60264-04	0.375	0.750	±0.0015	0.875	0.438	0.125	0.625	250	925	1.0	150
RLS132	6202112	60264-06	0.500	0.875	±0.0015	1.00	0.500	0.188	0.750	350	980	1.5	175
RLS140	6202120	60264-09	0.625	1.50	±0.0015	1.50	0.750	0.313	1.25	1750	3300	8.0	1200
RLS150	6202160	60264-11	0.750	1.50	±0.003	1.50	0.750	0.313	1.25	2500	4400	8.0	1200
RLS163	6202240	60264-15	1.00	1.75	±0.003	1.875	0.875	0.438	1.50	3500	6600	11.0	1500

METRIC UNIT	TRANTORQUE PART NO.	PHD PART NO.	d	D	D	L1	L2	B	A	MAX. TRANSMISSIBLE TORQUE	MAX. TRANSMISSIBLE THRUST	WEIGHT	INSTALLATION TORQUE ON NUT
			mm	mm	TOL.	mm	mm	mm	mm	Nm	kN	kg	Nm
RLS512	6202660	60265-02	6	16.0	±0.0015	19.0	9.5	3	13	16	3.4	0.014	19.1
RLS516	6202680	60265-04	8	19.0	±0.0015	22.0	11.0	3	16	23	4.0	0.028	17.0
RLS520	6202680	60265-04	8	19.0	±0.0015	22.0	11.0	5	16	23	4.0	0.028	17.0
RLS525	6202700	60265-06	10	22.5	±0.0015	25.5	12.5	5	19	30	4.2	0.042	19.8
RLS532	6202740	60265-09	14	25.5	±0.0015	28.5	16.0	5	22	44	4.4	0.560	22.6
RLS540	6202760	60265-11	16	25.5	±0.0015	28.5	16.0	5	22	50	4.5	0.560	22.6
RLS550	6202811	60265-17	20	45.0	±0.003	47.5	21.5	11	38	290	21.0	0.310	170
RLS563	6202835	60265-22	30	51.0	±0.003	57.0	21.5	13	46	580	35.4	0.450	225

NOTE: The torque required to install Trantorque adaptors exceeds the maximum value that can be safely applied to the rack and pinion assembly of Series RL Rotary Actuators. The tooling or component attached to the Trantorque adaptor must be constrained, to avoid excessive loading on the pinion gear, while the nut is being tightened to the torque specified above. Failure to follow this procedure will result in damage to the actuator.

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