Series QR
Rotary actuators with rack and pinion system

Magnetic, cushioned
7, 10, 20, 30, 50 mm
Rotation angles: 0 - 190°

- Compact design
- High rotation stability
- Adjustable rotation angle
- Easy to install
- Mechanical or hydraulic shock absorbers
- Can be integrated into manipulation systems

The Series QR rotary actuators are cylinders with a double piston, able to provide high torques while ensuring high stability and a precise rotary movement.
The rotation angle can be easily set as desired between 0° and 190° by means of adjustment bolts or hydraulic absorbers positioned on one side of the rotary table. The use of shock absorbers allows the dampening of two to five times more kinetic energy than with regulation bolts. The rotary table is compact and allows direct mounting of the load. Their compact design, lightness and ease to combine with EOAT make these actuators particularly suitable for use in the assembly and packaging sectors and any application that requires transfer, tilting or rotation of objects.

GENERAL DATA

Type of construction	"Rack & Pinion" system
Operation	double-acting
Materials	profile, end blocks and rotor = aluminium - rack = steel - pinion = steel – rack's guide ring = PTFE - seals = NBR
Type of mounting	by means of screws in the central body
Sizes	07, 10, 20, 30, 50
Operating temperature	0°C ÷ 70°C
Standard rotation angles	0 - 190°
Minimum rotation angle (with shock absorber)	10 = 66°, 20 = 52°, 30 = 46°, 50 = 70° (under these values the rotation is totally cushioned)
Repeatability	<0.2°
Bearings	ball bearings
Operating pressure	1 - 10bar, 1 - 7bar (for 7mm), 1-6bar (for versions with shock absorber)
Medium	filtered air in class 7.8.4 according to ISO 8573-1 standard. If lubricated air is used, it is recommended to use oil ISOVG32. Once applied the lubrication should never be interrupted.
Sensors	CSD

CODING EXAMPLE

QR	20	A

QR	SERIES	PNEUMATIC SYMBOL CD18
20	SIZE: 07 10 20 30 50	
A	TYPE OF CUSHIONING: A = MECHANICAL STOP S = SHOCK ABSORBER	

PNEUMATIC SYMBOL

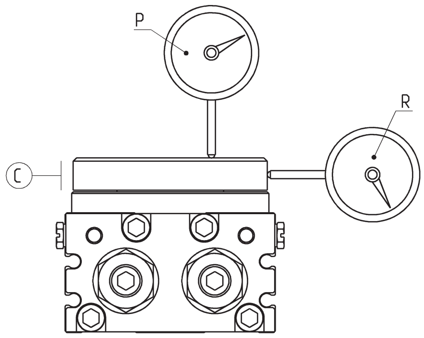
The pneumatic symbol indicated in the CODING EXAMPLE is reported below.

CD18

MAXIMUM PERMISSIBLE KINETIC ENERGY AND ROTATION TIMES

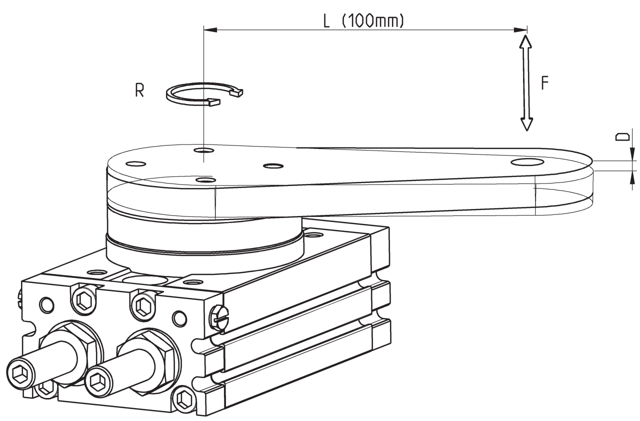
Size	Maximum permissible kinetic energy (J)	Maximum permissible kinetic energy (J)	Setting range of rotation time for stable use (s/90°)	Setting range of rotation time for stable use (s/90°)
	With adjustment bolt	**With shock absorber**	**With adjustment bolt**	**With shock absorber**
07	**0.006**	**-**	**0.2 - 1.0**	**-**
10	**0.01**	**0.04**	**0.2 - 1.0**	**0.2 - 1.0**
20	**0.025**	**0.12**	**0.2 - 1.0**	**0.2 - 1.0**
30	**0.05**	**0.12**	**0.2 - 1.0**	**0.2 - 1.0**
50	**0.08**	**0.30**	**0.2 - 1.0**	**0.2 - 1.0**

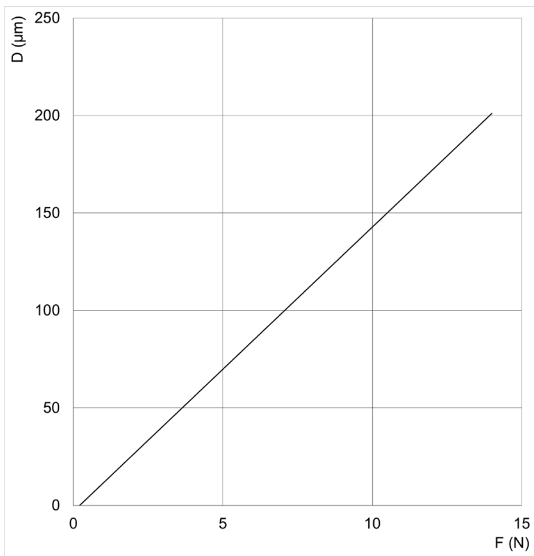
GEOMETRIC TOLERANCES OF THE ROTARY TABLE



P = Parallelism of the rotary table 0,1mm
R = Roundness of the rotary table 0,1mm
C = Cylindricity of the rotary table 0,1mm

MISALIGNMENT OF THE ROTARY TABLE

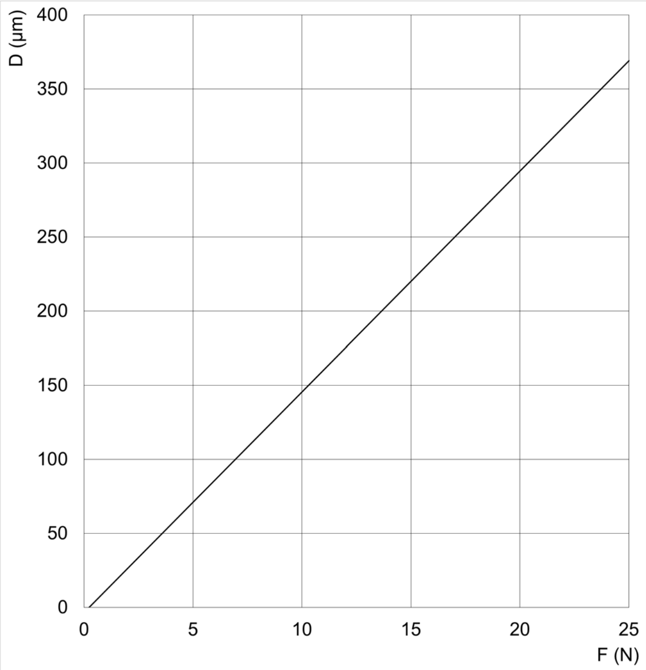




R = Direction of rotation
L = Arm
D = Misalignment table

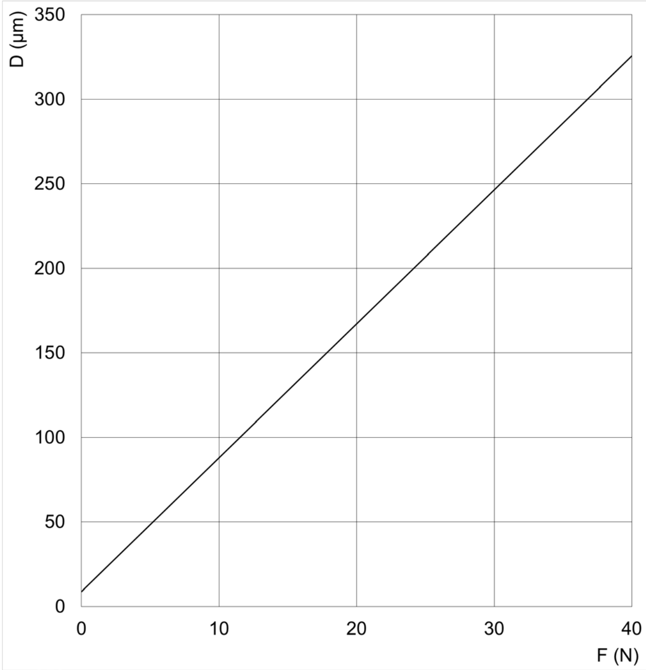
QR07
D = Misalignment
F = Force

MISALIGNMENT OF THE ROTARY TABLE



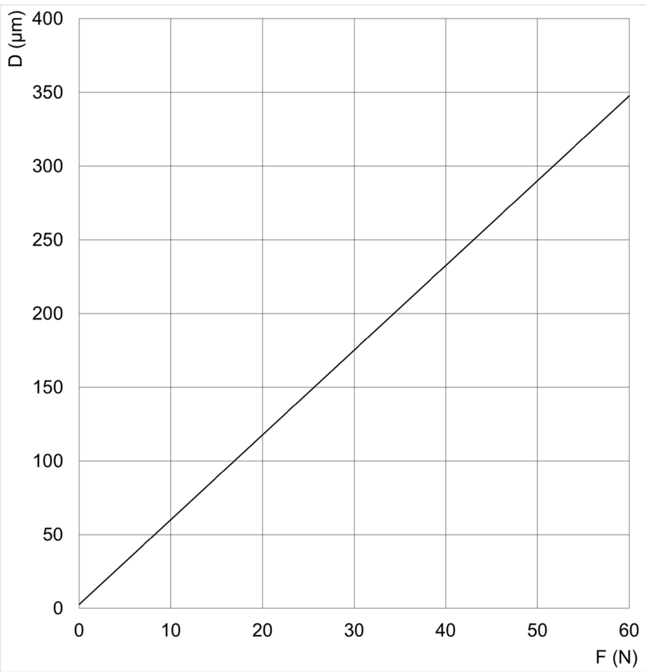
QR10

D = Misalignment
F = Force



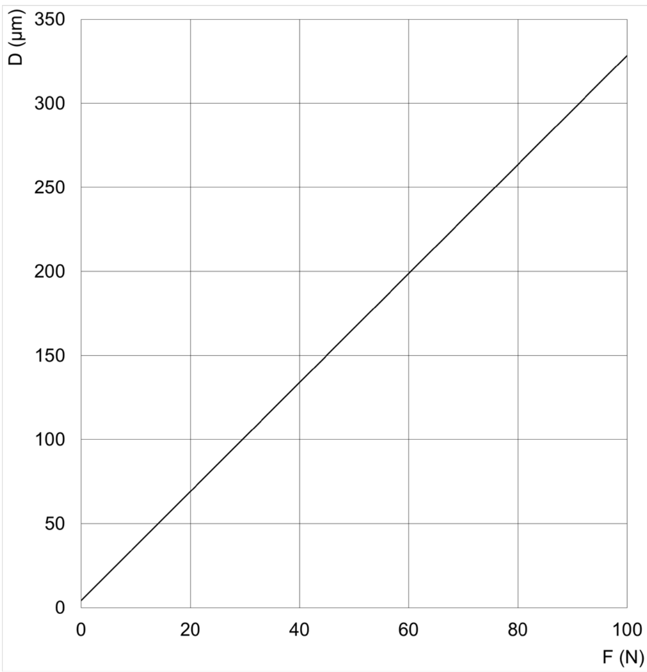
QR20

D = Misalignment
F = Force



QR30

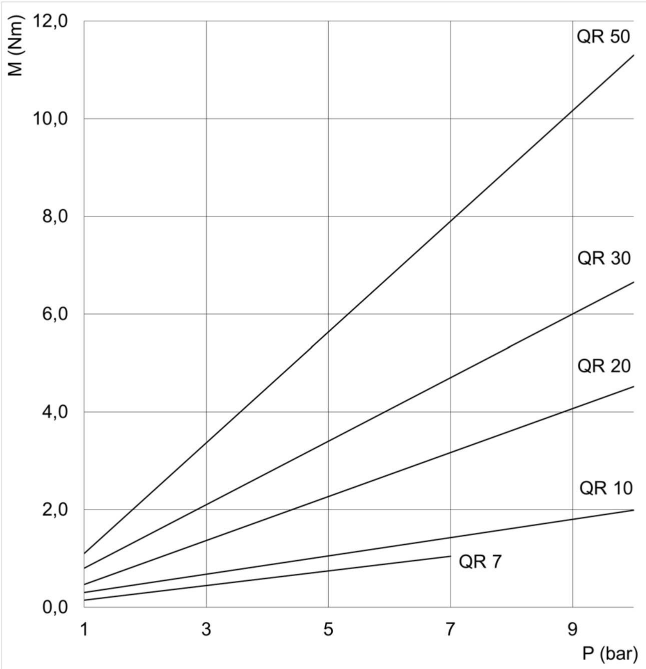
D = Misalignment
F = Force

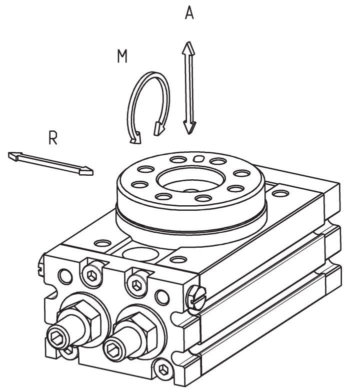


QR50

D = Misalignment
F = Force

OUTPUT TORQUE AND PERMISSIBLE LOADS





M = Output torque
P = Pressure

Maximum permissible load

Size	R radial (N)	A axial (N)	M moment (Nm)
07	47	65	1.3
10	75	73	2.3
20	142	132	3.9
30	192	189	5.1
50	309	291	9.5

SIZING / CHOICE OF THE ACTUATOR

HOW TO CHOOSE THE SUITABLE ROTARY ACTUATOR:

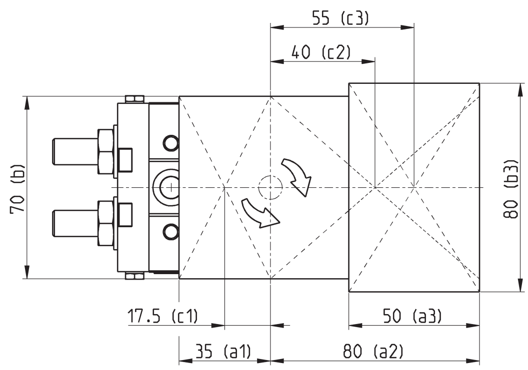
OPERATING CONDITIONS:

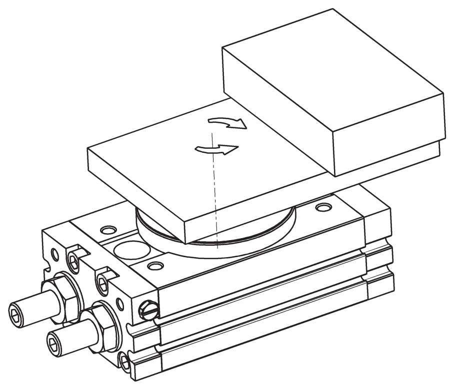
Pressure: 4bar (0.4 MPa)
Rotation angle: 90°
Rotation time: 1.0 second
Load:
P1 = mass of the plate at the left of the centre of rotation 0.066 kg
P2 = mass of the plate at the right of the centre of rotation 0.151 kg
P3 = mass of the load 0.216 kg

1) ROTATION TIME
Check whether the rotation time requested by the application falls within the range of values of the section "kinetic energy and rotation times".

Requested rotation time: 1.0 s/90°

2) NECESSARY TORQUE
Check whether the torque requested by the application falls within the range of values defined in the section "output torque and permissible loads".

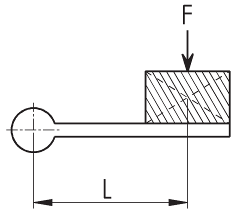




TYPES OF LOAD:

-STATIC LOAD (Ts)
A load that requires pressure force only

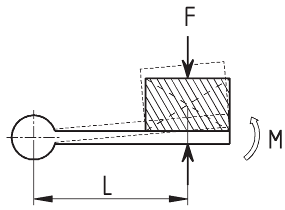
F = pressure force (N)
L = arm between the barycentre of the load and the centre of the axis (mm)



$$Ts = F \cdot L \; (Nm)$$

-RESISTANCE LOAD (Tf)
A load that is affected by external forces such as friction and gravity. Since the aim is to move the load, it is necessary to adjust the speed and leave a margin of 5/6 N of actual torque.

M = actual torque of the actuator (Nm)
µ = friction coefficient
m = mass of the load (kg)
g = gravitational acceleration (m/s^2)

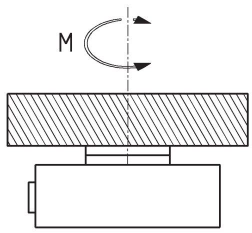


$$M \geq (3 \div 5) \cdot Tf \; (Nm)$$
$$F = \mu \cdot m \cdot g \; (N)$$
$$g = 9.8 \; (m/s^2)$$
$$Tf = F \cdot L \; (Nm)$$

- LOAD OF INERTIA (Ta)
The load must be rotated by the actuator, it is necessary to adjust the speed and leave a margin of 10N of actual torque.

M = actual torque of the actuator (Nm)
l = moment of inertia (kgm^2)
α = angular acceleration (rad/s^2)
θ = rotation angle
t = rotation time (s)

In the example the only force to overcome is the force of inertia as the other two are null.



$$M \geq 10 \cdot Ta \; (Nm)$$
$$Ta = I \cdot \alpha \; (Nm)$$
$$\alpha = \frac{2 \cdot \theta}{t^2} \; (rad/s)$$

Start calculating the moment of inertia (I) based on the load.

I1 - PLATE
I3 - LOAD

$$I_1 = m_1 \cdot (4 \cdot a_1^2 + b^2)/12 + m_2 \cdot (4 \cdot a_2^2 + b^2)/12 =$$
$$0.066 \cdot (4 \cdot 0.035^2 + 0.07^2)/12 + 0.151 \cdot (4 \cdot 0.08^2 + 0.07^2)/12 = 0{,}00044 \; Kgm^2$$
$$I_3 = m_3 \cdot (4 \cdot a_3^2 + b_3^2)/12 + m_3 \cdot c_3^2 =$$
$$0.216 \cdot (4 \cdot 0.05^2 + 0.08^2)/12 + 0.216 \cdot 0.055^2 = 0{,}00095 \; Kgm^2$$

The total moment of inertia (I) is:

$$I = I_1 + I_3 = 0{,}00044 + 0{,}00095 = 0.00139 \; Kgm^2$$

Calculate the angular acceleration (α).
Based on the conditions θ=90° =π/2 rad, t=1.0s you will have:
Therefore the load of inertia (Ta) equal to the necessary torque, is given by:
µ= safety coefficient

$$\alpha = 2 \cdot \theta / t^2 = (2 \cdot \pi/2)/1^2 = 3.14 \; rad/s^2$$
$$Ta = \mu \cdot I \cdot \alpha$$
$$Ta = 5 \cdot 0.00139 \cdot 3.14 = 0.00218 \; Nm$$

3) PERMISSIBLE KINETIC ENERGY
Check whether the kinetic energy requested by the application falls within the range of values of the section “maximum permissible kinetic energy and rotation times”

Kinetic energy (E) is given by:

$$E = 0.5 \cdot I \cdot \alpha^2 = 0.5 \cdot 0.00218 \cdot 3.14^2 = 0.0068 \; J$$

4) MAXIMUM PERMISSIBLE LOAD
Check whether the maximum load requested by the application falls within the range of values of the section “output torque and permissible loads” and respects the following relation:

$$\frac{Ws}{MWs} + \frac{Wr}{MWr} + \frac{M}{MM} \leq 1$$

Ws = actual axial load
MWs = max axial load
Wr = actual radial load
MWr = max radial load
M = actual torque
MM = max torque

AXIAL LOAD (Ws)

The axial load (Ws) is given by:

PT=P1+P2+P3 = 0.066+0.151+0.216= 0.43 Kg

Ws= PT · g = 0.43 · 9.81= 4.21 N

RADIAL LOAD (Wr) - there is no radial load (Wr)

ACTUAL TORQUE (M)

F1 = force on the area of the plate at the left of the centre of rotation (N)
c1 = arm of F1 (m)

F1= P1 · g = 0.066 · 9.81= 0.64 N

F2 = force on the area of the plate at the right of the centre of rotation (N)
c2 = arm of F2 (m)
M1 = moment generated by the whole plate (Nm)

F2= P2 · g = 0.151 · 9.81= 1.48 N

M1= F1 · c1 - F2 · c2 = 1.48 · 0.04-0.64 · 0.0175= 0.048 Nm

F3 = force of the weight of the load (N)
M3 = moment generated by the load (Nm)

F3= P3 · g = 0.216 · 9.81= 2.11 N
M3= F3 · c3= 2.11 · 0.055= 0.116 Nm

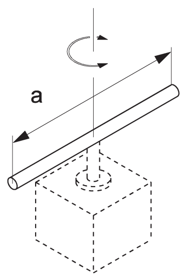
The actual torque (M) is given by summing M1 + M3:

M= M1+M3= 0.048+0.116= 0.164 Nm

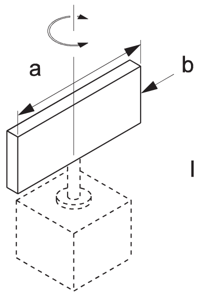
5) CHOICE OF THE SUITABLE ACTUATOR
With the results obtained from the points above, we can say that:
1. Rotation time 1.0s/90° is satisfied by all sizes
2. Total load of 0.0218 Nm at 4bar is already guaranteed by QR07
3. Kinetic energy of 0.0068J is guaranteed by size 10
4. Maximum permissible load of QR10A is major than the one examined.

The most suitable rotary actuator for the application is QR10A

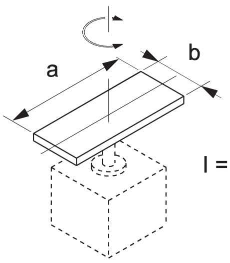
HOW TO CALCULATE THE MOMENT OF INERTIA



$$I = m \cdot \frac{a^2}{12}$$



$$I = m \cdot \frac{a^2}{12}$$

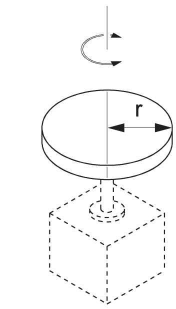


$$I = m \cdot \frac{a^2 + b^2}{12}$$

1-THIN SHAFT
Axis of rotation perpendicular to the shaft, aligned to the barycentre

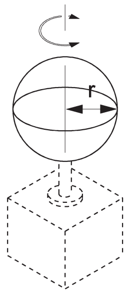
2-THIN RECTANGULAR PLATE
Axis of rotation parallel to side b, aligned to the barycentre

3-THIN RECTANGULAR AND PARALLELEPIPED PLATE
Axis of rotation perpendicular to the plate, aligned to the barycentre



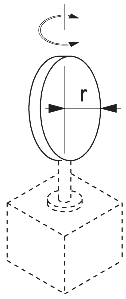
$$I = m \cdot \frac{r^2}{2}$$

4-ROUND PLATE OR COLUMN
Axis of rotation passing through the central axis



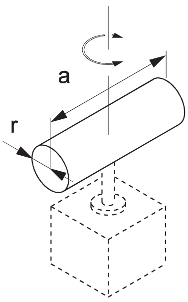
$$I = m \cdot \frac{2r^2}{5}$$

5- SOLID SPHERE
Axis of rotation passing through the centre of the diameter



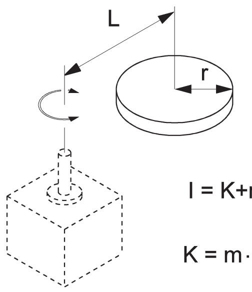
$$I = m \cdot \frac{r^2}{4}$$

6-THIN ROUND PLATE
Axis of rotation passing through the centre of the diameter



$$I = m \cdot \frac{3r^2 + a^2}{12}$$

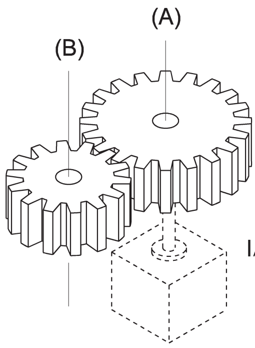
7-CYLINDER
Axis of rotation passing through the central axis and aligned to the barycentre



$$I = K + m \cdot L^2$$

$$K = m \cdot \frac{r^2}{2}$$

8-AXIS OF ROTATION AND BARYCENTRE NOT ALIGNED
K = moment of inertia on the barycentre of the load, to replace with one of the previous figures (for example 4)

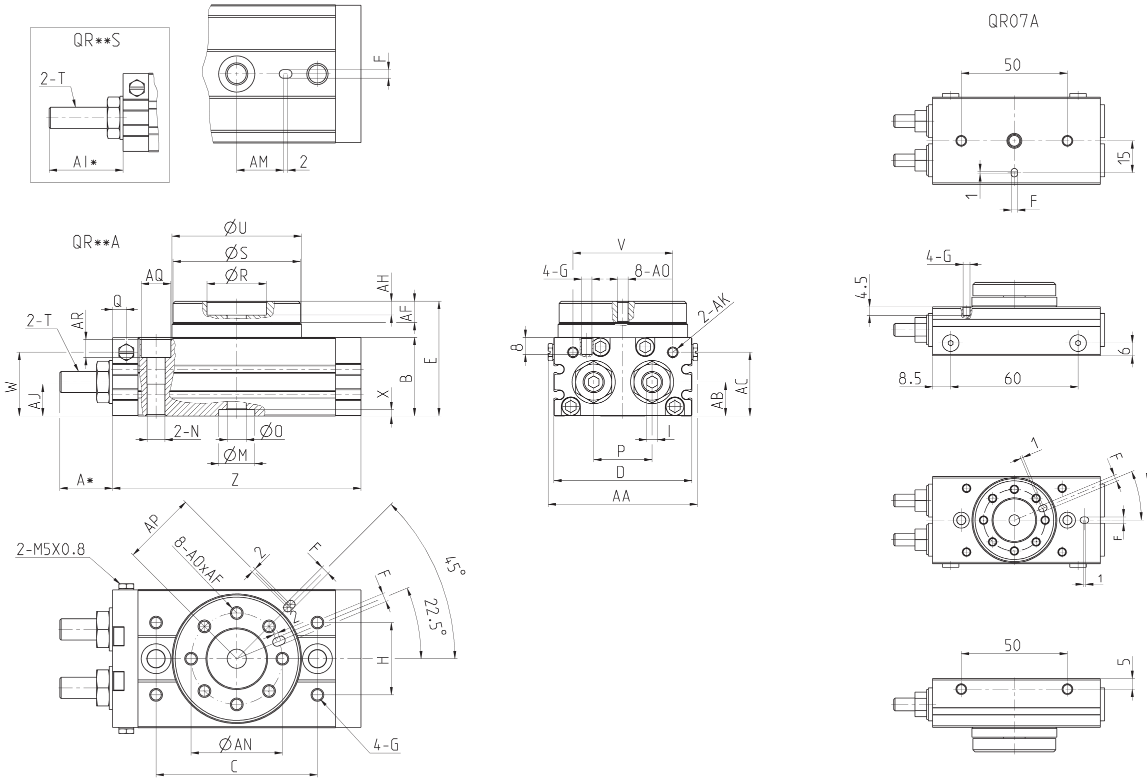


$$I_A = \left(\frac{a}{b}\right)^2 \cdot I_B$$

9-TRANSMISSION THROUGH TOOTHED GEARS
1) Calculate the moment of inertia “IB” for the rotation of shaft “B”
2)”IB” is converted into moment of inertia “IA” for the rotation of shaft “A”
a/b = n° of teeth of toothed gears

SERIES QR ROTARY ACTUATORS

* maximum protrusion, with 190 ° rotation angle adjustment



Mod.	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
07	18.3	23	45	41	34.5	3	M4X0.7	30	3	-	7	M5x0,8	6	18.4	-	20	39	M4X0.7	40	-	-	-	M5X0.8	79
10	17.3	34	60	50	47	3	M5X0.8	27	4	9.5	15	M8x1,25	5	20	5	20	45	M8X1	46	34.5	28	3.5	M8X1.25	92
20	24.8	37	76	65	54	4	M6X1	34	5	12	17	M10x1,5	9	27.5	6.5	28	60	M10X1	61	47	30	3	M10X1.5	117
30	24.8	40	84	70	57	4	M6X1	37	5	12	22	M10x1,5	10	29	7	32	65	M10X1	67	50	33.5	3.5	M10X1.5	127
50	31.3	46	100	80	66	5	M8X1.25	50	6	15.5	26	M12x1,75	11	38	10	35	75	M14X1.5	77	63	37.5	3.5	M12X1.75	152

Mod.	AA	AB	AC	AF	AH	AI	AJ	AK	AM	AN	AO	AP	AQ	AR
07	42.7	12.2	-	6.3	3	-	-	-	.	29	M4X0.7	32.5	7.5	4.5
10	55.4	15.5	28	8	4.5	30.9	12	M5X0.8	19	32	M5X0.8	27	11	6.5
20	70.4	16	30	10	6.5	34.8	15	M5x0.8	24	43	M6x1	36	14	8.5
30	75	18.5	32	10	5	34.8	15	G1/8	28	48	M6x1	39	14	8.5
50	85	22	37.5	12	5.5	54.3	18	G1/8	33	55	M8x1.25	45	18	10.5