PNEUMATIC GRIPPERS

GENERAL

① Pneumatic gripper
② Jaws
③ Clamping finger
④ Sensor slot
⑤ F = clamping force of one jaw only
If a gripper has three jaws, with F = 25N, so the total clamping force is 25 x 3 = 75N.
⑥ Load
⑦ L = distance between the barycentre of the load and the reference surface
⑧ C = stroke of a single jaw

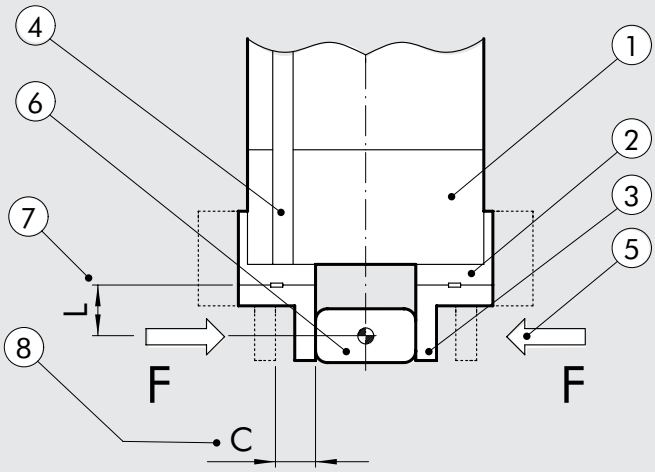
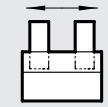


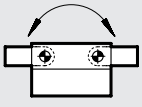
FIG. 1.1

GENERAL

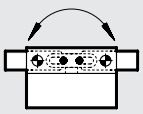


Parallel gripper: the jaws move in a straight line. There may be two, three or even four jaws.

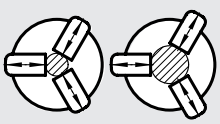
Hinged gripper: the jaws are hinged and move along the arc of a circle. It is generally cheaper than a parallel gripper but there are some limitations (see drawing 1.6):
- If the part has varying dimensions, the contact area changes.
- If the part is cylindrical with varying dimensions, the position of the axis of the clamped part varies.



Gripper with retracting jaws: the jaws have an opening angle of about 90°. The clamping fingers can retract fully from the work top, and so, in certain cases, it is possible to avoid one linear retraction motion (see drawing 1.5).



Toggle gripper: a hinged gripper with a toggle-action mechanism to achieve high clamping forces. Clamping is irreversible even when there is no pressure, so the part cannot be released accidentally. The opening angle is 90° so it acts as retracting gripper. The clamping force is high within a limited angle only.



Number of jaws: two-jaw grippers are used for prism-shaped parts or cylindrical ones with a single diameter. Three-jaw grippers can be used for cylindrical parts with different diameters.

CLAMPING FINGERS

FIG. 1.2

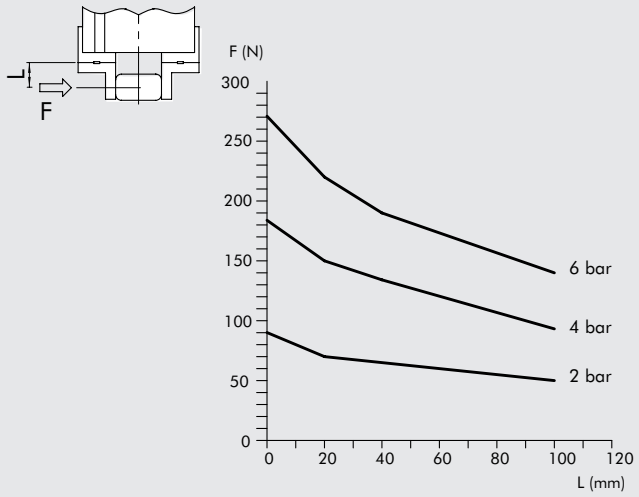
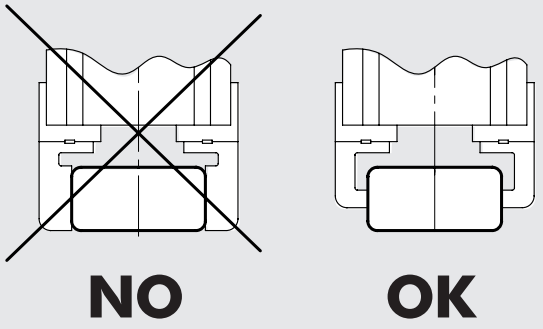


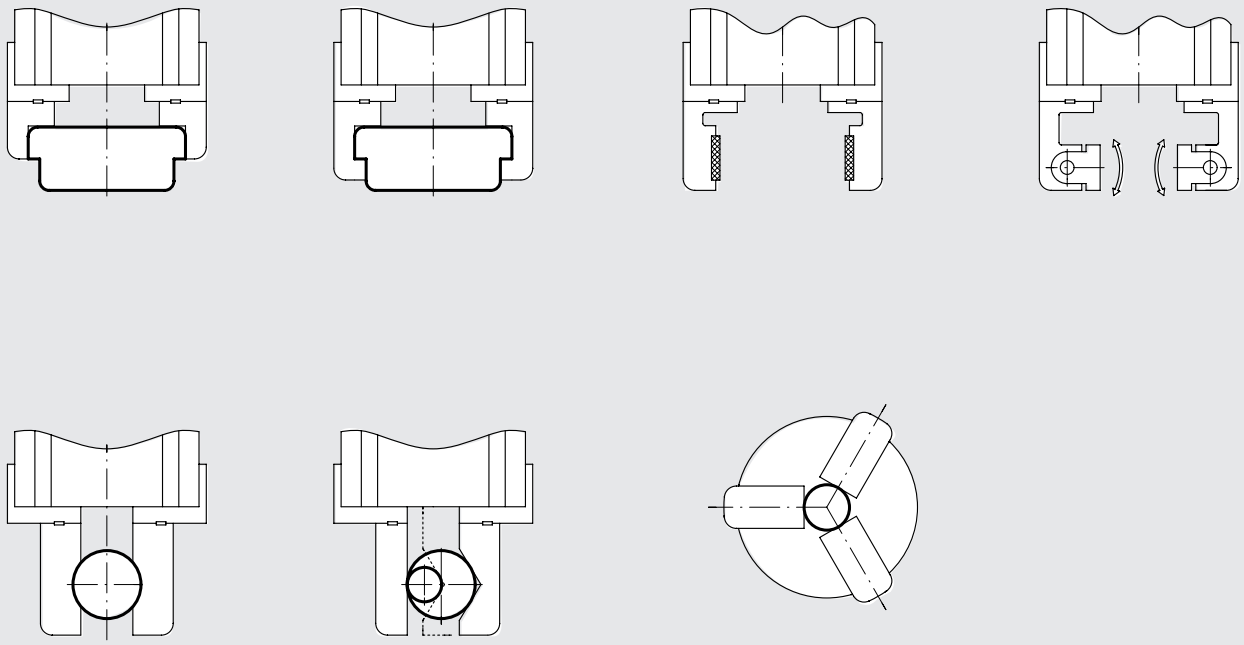
FIG. 1.3



The clamping fingers must be as light and short as possible to keep inertia to a minimum.
The longer the clamping fingers, the less force is available (see fig. 1.2).
Wider fingers are only heavier, they do not increase friction (see fig. 1.3).

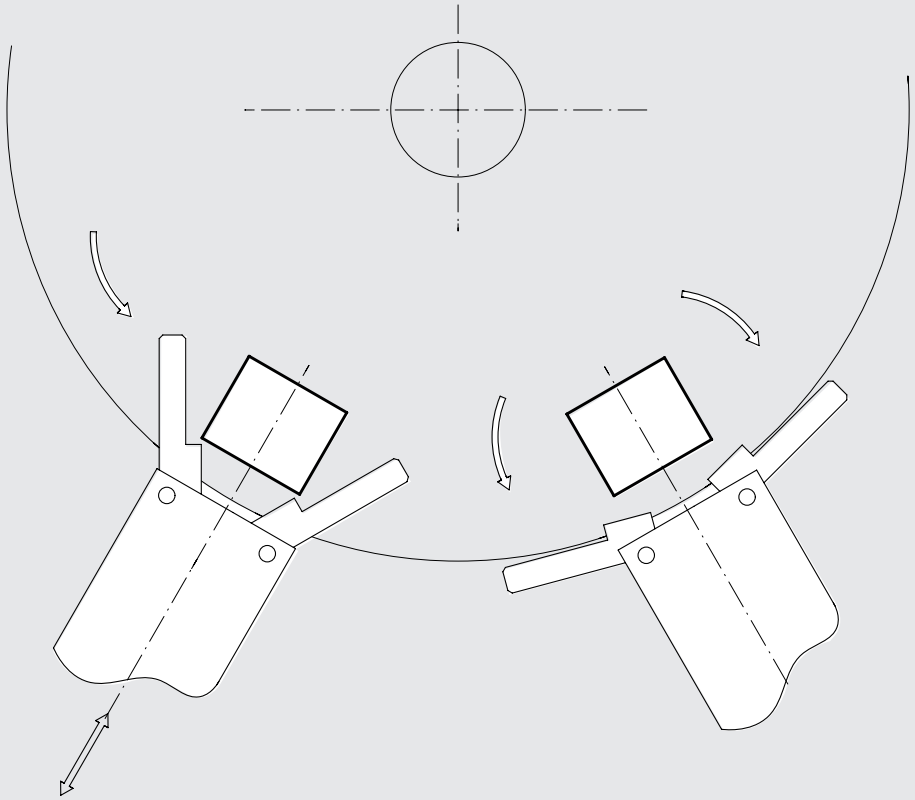
FEATURES

FIG. 1.4



EXAMPLE OF RETRACTING HINGED GRIPPERS

FIG. 1.5



EXAMPLE OF USE LIMITATIONS OF HINGED GRIPPERS

FIG. 1.6

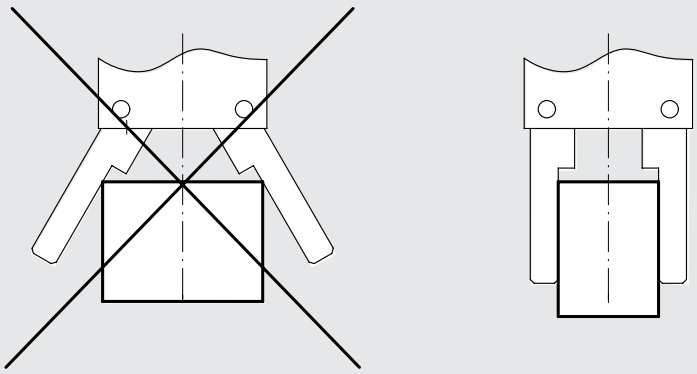
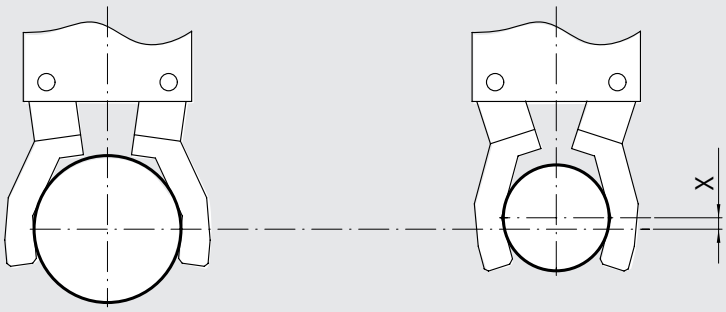


FIG. 1.7

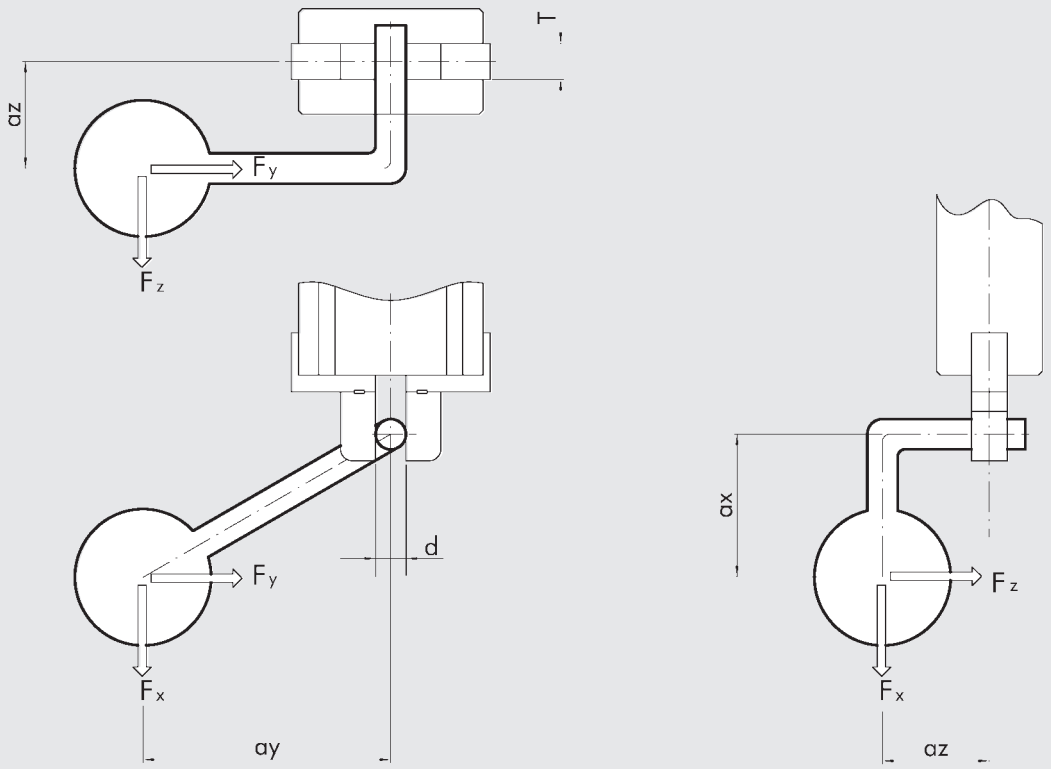


CALCULATIONS

First of all, determine the necessary clamping force.
Then decide which type of gripper can ensure this force with required pressure and clamping distance.
To help designers calculate the clamping force, we propose two levels of calculation.

DRAWING TO CALCULATE GRIPPER CLAMPING FORCE

FIG. 1.8



APPROXIMATION METHOD

Clamping force of each jaw [N] ≥ 200 x weight of part [kg] / number of jaws.

	Data	Unit of measurement	Formula	Example	
M	Mass of part	kg		1.2	
n	Number of jaws	–		3	
F	Clamping force of each jaw	N	≥ 200 x M / n	≥ 200 x 1.2 / 3 = 80	

PRECISION COMPUTING METHOD

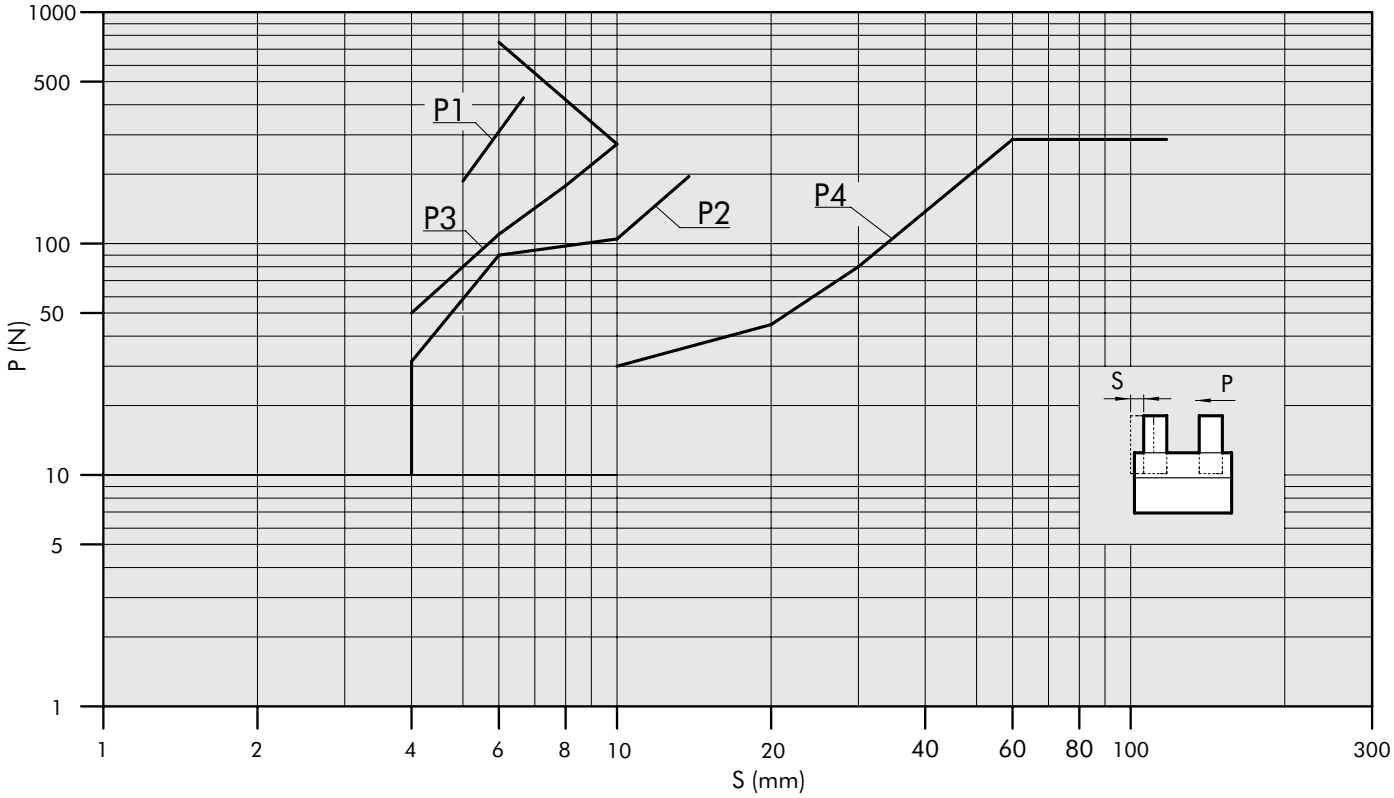
	Data	Unit of measur.	Formula	Example
M	Mass of part	Kg		1,2
a	Acceleration	m/s^2		5 in direction X
Ω	Angle speed	rad/s		0
T	Width of clamping finger	mm		8
d	Clamping diameter of part	mm		16
ax	Distance along X of the barycentre from clamping centre	mm		0
ay	Distance along Y of the barycentre from clamping centre	mm		0
az	Distance along Z of the barycentre from clamping centre	mm		25
μ	Finger/part friction coefficient			0,2
	Some examples:			
	Smooth steel on smooth metal		μ = 0,1	
	Rough steel on smooth metal		μ = 0,2-0,3	
	Soft material, e.g. Vulkolan		μ = 0,4	
	Coupled shape (vedi fig. 1.4)		μ = 1	
	Forces applied to barycentre of part.			
	When determining the forces, assess for each direction:			
	Force x weight	N	M x 9,81	
	Force of inertia x linear acceleration	N	Mx a	
	Force of inertia x angular velocity	N	$M \times \Omega^2 \times r$	
Fx	Force along gripper axis	N		Fx = peso 1.2 x 9.81 = 11.8 N
Fy	Force perpendicular to jaw	N		Fy = F.of inertia = 1.2 x 5 = 6 N
Fz	Force tangent to jaw	N		Fz = O
	Force equivalent to clamping centre:			
Ft eq	Equivalent tangential force	N	$\sqrt{\left[Fx \cdot \left(\frac{az+\frac{T}{2}}{T}+\frac{ay+\frac{d}{2}}{d}\right)+Fz\cdot\frac{ax}{T}+Fy\cdot\frac{ax}{d}\right]^2+Fz^2}$	$\sqrt{\left[11.8\cdot\frac{25+\frac{8}{2}}{8}+O\right]^2}=42.8\ N$
Fy eq	Equivalent perpendicular force	N	$Fy\cdot\frac{az+\frac{T}{2}}{T}+Fz\cdot\frac{ay}{T}$	$=6\cdot\frac{\left(25+\frac{8}{2}\right)}{8}=75\ N$
Fs teo	Theoretical clamping force	N	Greater of (Fteq/2μ) and (Fyeq)	Greater of (42.8/2.02) and 75 = 107
F	**Clamping force**	N	FsTeo · 1.5 (safety coefficient)	= 107 · 1.5 = 160 N

COMPARATIVE CHARTS FOR GRIPPERS

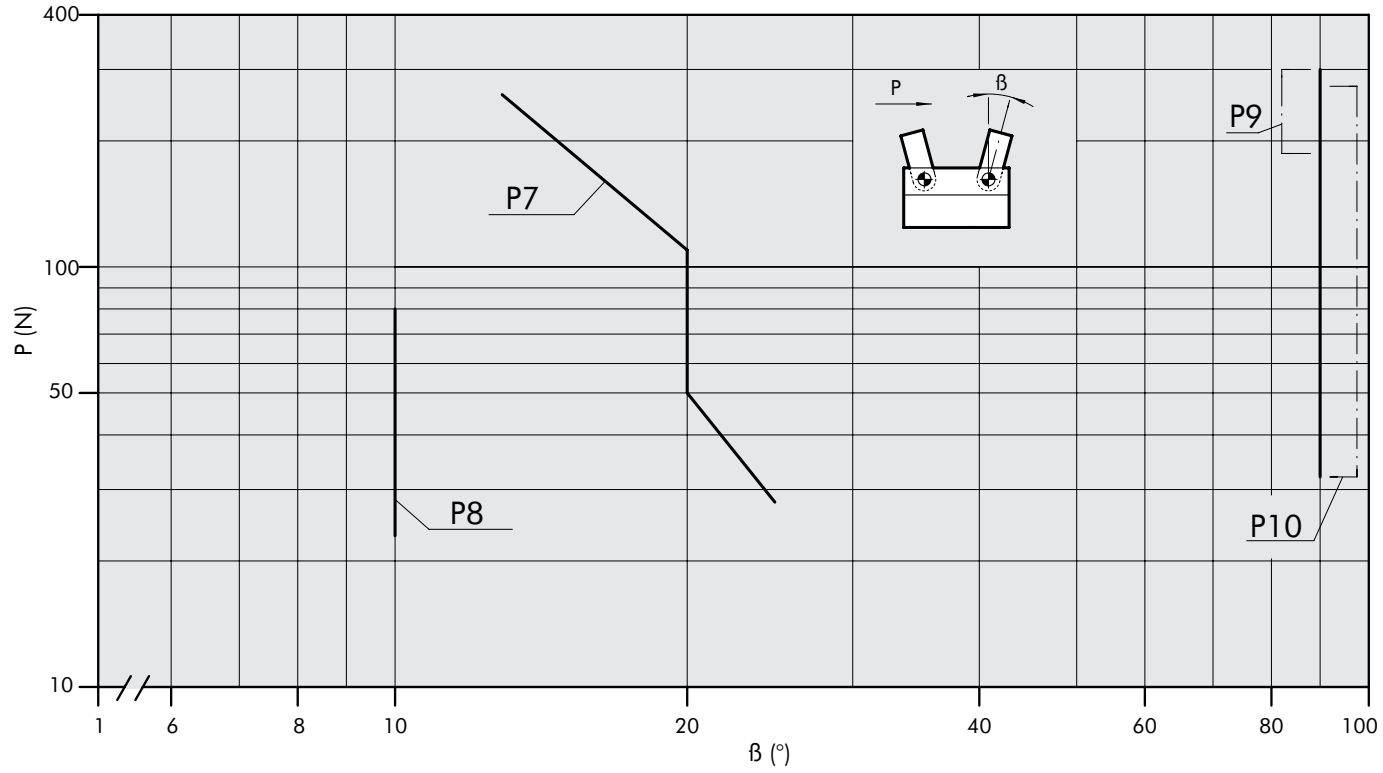
The lines plotted on the graphs below show the following for each series of gripper:
- Clamping force (at 6 bar)
- Stroke (linear or angular)

This allows you to determine the most appropriate series to meet your requirements. For instance, if you want a gripper with two parallel jaws, a clamping force greater than 100 N and stroke greater than 12 mm, you can find it in series P2 or P4.

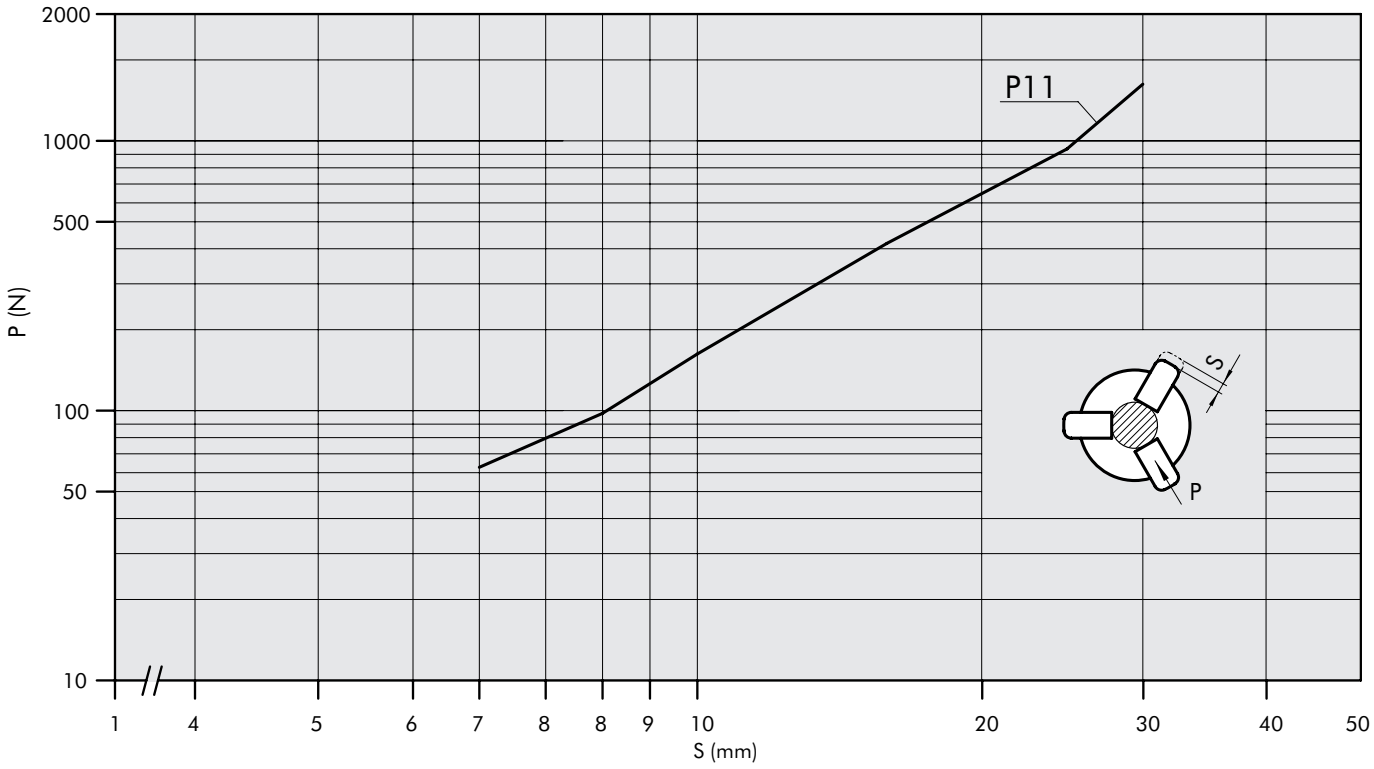
COMPARATIVE CHART - GRIPPERS WITH TWO PARALLEL JAWS



COMPARATIVE CHART - GRIPPERS WITH TWO HINGED JAWS

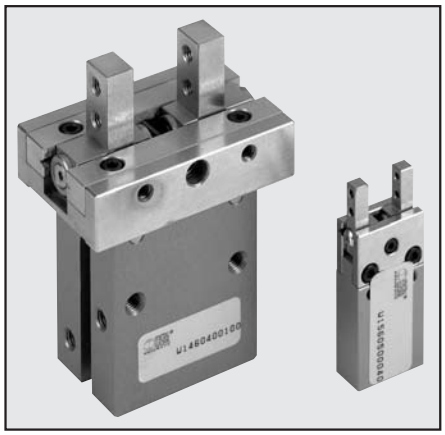


COMPARATIVE CHART - GRIPPERS WITH THREE JAWS

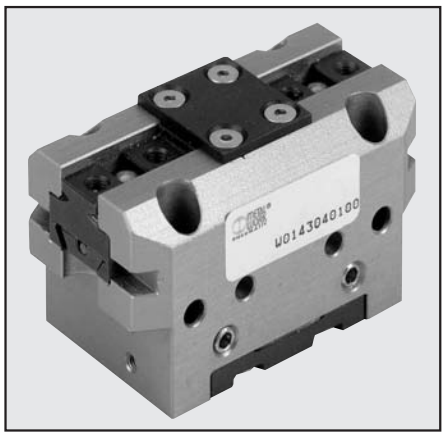


NOTES

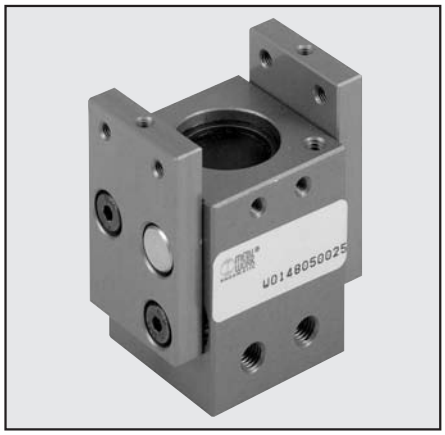
• Serie P1
This is a gripper with an excellent quality-to-price ratio.
Double action with internal or external clamping. All size come with magnets and sensor slot. The materials used and the heat and chemical treatments applied means that the parts subject to stress are extra-resistant.



• Serie P2
This is a gripper with rollers recirculation jaw guides.
Starting from very small sizes – minimum thickness 10 mm.
Larger sizes have a system for taking up jaw guide play.
Double action with internal or external clamping.
Comes with magnet and sensor slot.



• Serie P3
High-precision sturdy gripper guaranteed for 1,500,000 cycles with max load without maintenance.
Top quality materials, accurately worked: body made of highly-resistant hardened aluminium alloy body. Moving parts made of hardened and tempered steel.
Double action with internal or external clamping.
Special versions available on request:
• With induction sensors
• 5-position monitoring using a positionable sensor.
• With spring lock device for when there is no pressure.
• Double clamping force and half stroke.



• Serie P4
Gripper with a long stroke.
The shape of the jaws makes them particularly suitable for clamping parts of large size with respect to the weight.
Double action with internal or external clamping.
Magnets for position sensors.

GRIPPERS WITH TWO HINGED JAWS

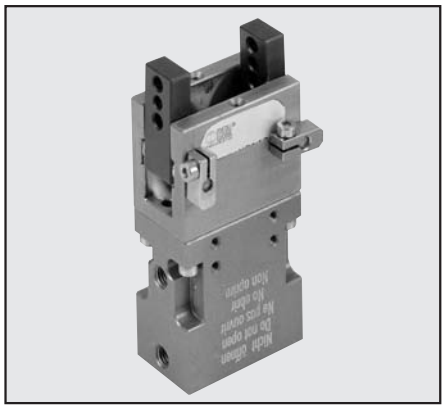
• Serie P7
This is a double-acting gripper with an excellent quality-to-price ratio. Designed for application of a retracting magnetic sensor. The body is in a single piece.
Simplified jaw replacement method.
Provided with magnets and sensor slots.

• Serie P8
Single-acting normally open grippers. Virtually all the component parts are made of technopolymer to make the device lighter. The smallest version is really tiny – it weighs a mere 36 g.

GRIPPERS WITH TWO RETRACTING JAWS

The following two series of wide-opening grippers can be used for specific applications.

• Serie P9
Toggle-type pivoted grippers for external clamping, up to 180° opening angle and high clamping forces.
The workpiece is not released, even when the power is cut off. Provided with magnets and sensor slots.



• Serie P10
Grippers with 20°-180° adjustable opening designing for gripping the part from the outside. With high clamping forces. There is also a version with springs for extra safety during pressure drops. Each of the two fingers can be adjusted by about 1°. Top quality materials and accurate working. Highly resistant hardened aluminium alloy body. Moving parts made of tempered steel. 2,000,000 cycles without maintenance. Induction sensors can be mounted.

GRIPPERS WITH THREE JAWS

• Serie P11
Grippers with a good quality-to-price ratio. Double action with internal or external clamping. Magnets for position sensors, slim type.
Four-jaw self-centring version available on request.