GRIPPERS, ROTARY ACTUATORS, SLIDES SUMMARY

GRIPPERS

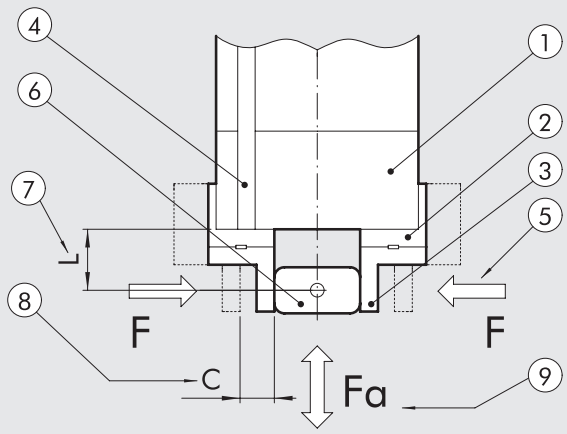
ROTARY ACTUATORS

GENERAL TECHNICAL DATA GRIPPERS

NOMENCLATURE

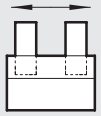
① Pneumatic gripper
② Jaws
③ Clamping finger
④ Sensor slot
⑤ F = clamping force of one jaw only
If a gripper has three jaws, with
F = 25 N, so the total clamping force is 25 x 3 = 75 N
⑥ Load
⑦ L = distance between the barycentre of the load and the reference surface
⑧ C = stroke of a single jaw
⑨ Fa = maximum axial force applied to the grippers

FIG. 1.1



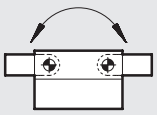
TYPES

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

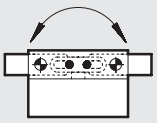


Hinged gripper: the jaws are hinged and move along the arc of a circle. It is generally cheaper than a parallel gripper but there are some limitations (see fig. 1.5):
- If the part has varying dimensions, the contact area changes (see fig. 1.6)
- If the part is cylindrical with varying dimensions, the position of the axis of the clamped part varies (see fig. 1.7)

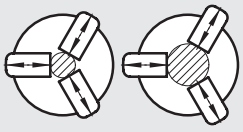
Gripper with retracting jaws: the jaws have an opening angle of about 90°. The clamping fingers can retract fully from the work top, and so, in certain cases, it is possible to avoid one linear retraction motion (see fig. 1.5).



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.



METAL WORK PNEUMATIC

CLAMPING FINGERS

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).

FIG. 1.2

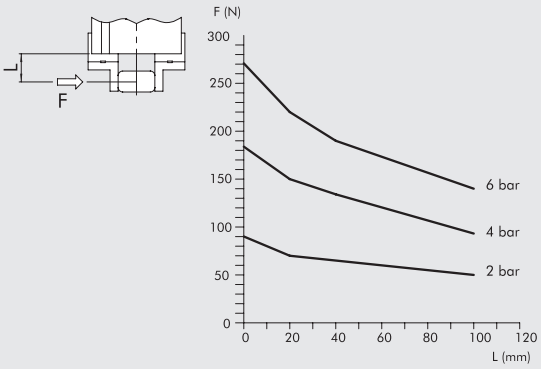
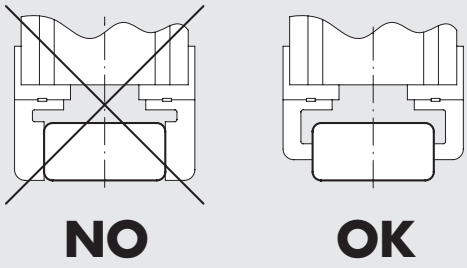
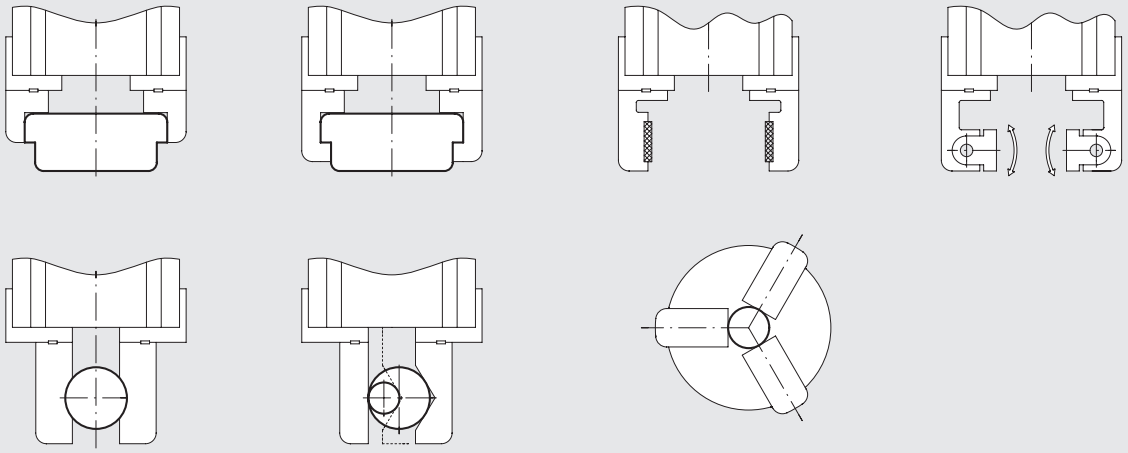


FIG. 1.3



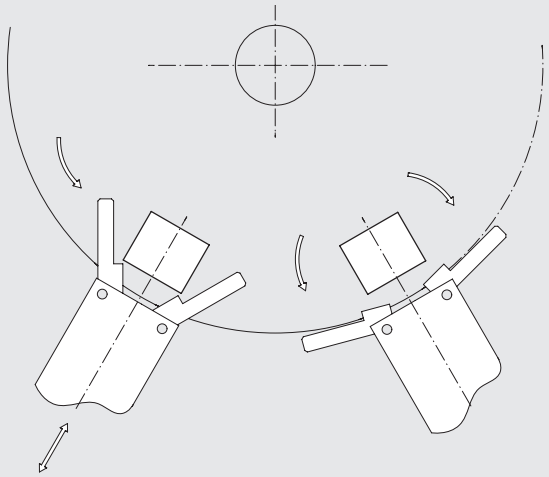
EXAMPLE OF CLAMPING FINGERS

FIG. 1.4



EXAMPLE OF RETRACTING HINGED GRIPPERS

FIG. 1.5



EXAMPLE OF USE LIMITATIONS OF HINGED GRIPPERS

FIG. 1.6

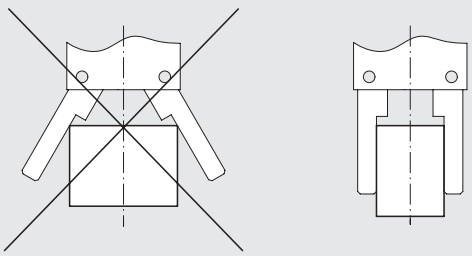
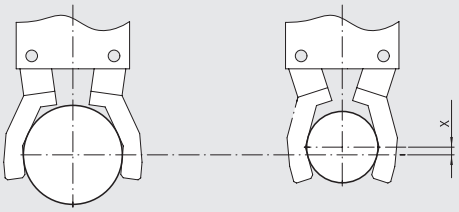


FIG. 1.7

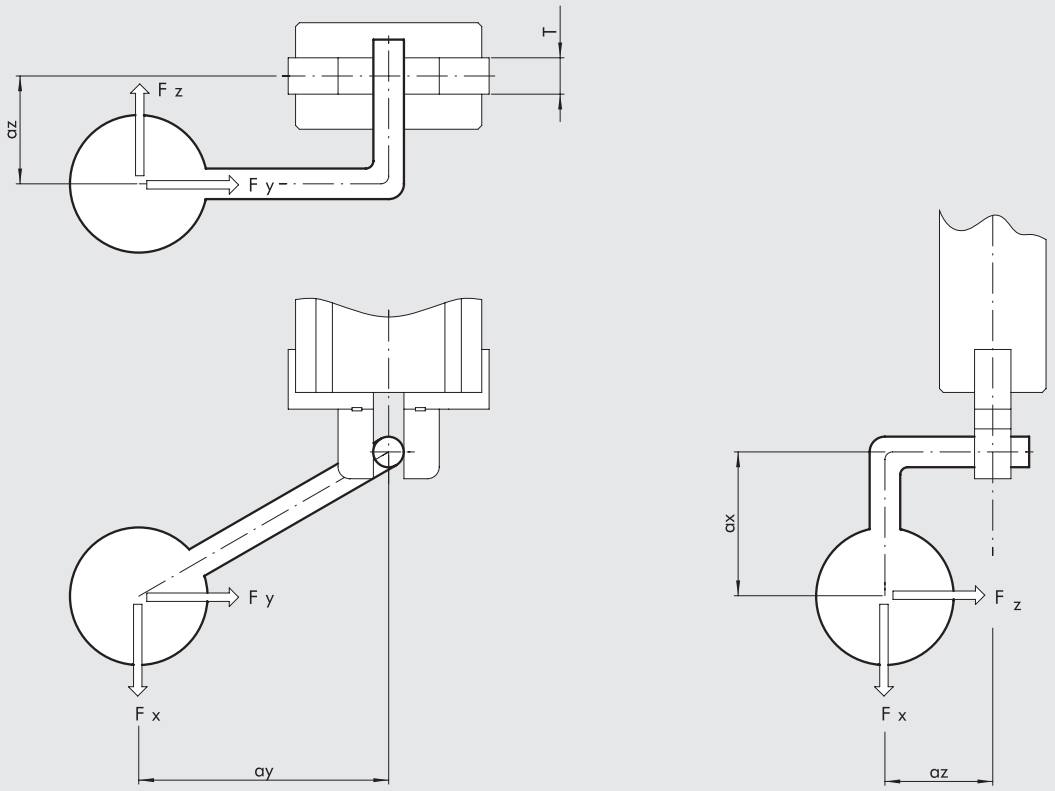


CALCULATIONS

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

METAL WORK PNEUMATIC

PRECISION COMPUTING METHOD

	Data	Unit of measur.	Formula	Example
M	Mass of part	kg		1.2
a	Acceleration	m/s^2		5 in direction Y
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	M x a	
	Force of inertia x angular velocity	N	$M \times \Omega^2 \times r$	
Fx	Force along gripper axis	N		Fx = weight 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	$\sqrt{\left[Fx \cdot \left(\frac{az+\frac{T}{2}}{T}+\frac{ay+\frac{d}{2}}{d}\right)+Fz \cdot \frac{ax}{T}+Fy \cdot \frac{ax}{d}\right]^2+Fz^2}$	$\sqrt{\left[11.8 \cdot \left(\frac{25+\frac{8}{2}}{8}+\frac{1}{2}\right)+O\right]^2} = 48.6\,N$
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 · 0.2) and 75 = 107 N
F	Clamping force	N	FsTeo · 1.5 (safety coefficient)	= 107 · 1.5 = 160 N

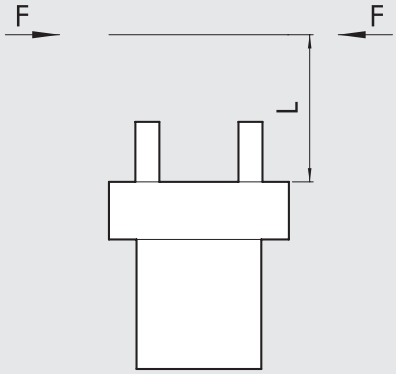
NOTES

GRIPPER WITH TWO PARALLEL JAWS SERIES P1

- Dual-acting parallel gripper for internal and external clamping.
- Anodized aluminium alloy body and tempered steel jaws.
- Bottom or side fixing.
- All sizes come with magnets and sensor slots.

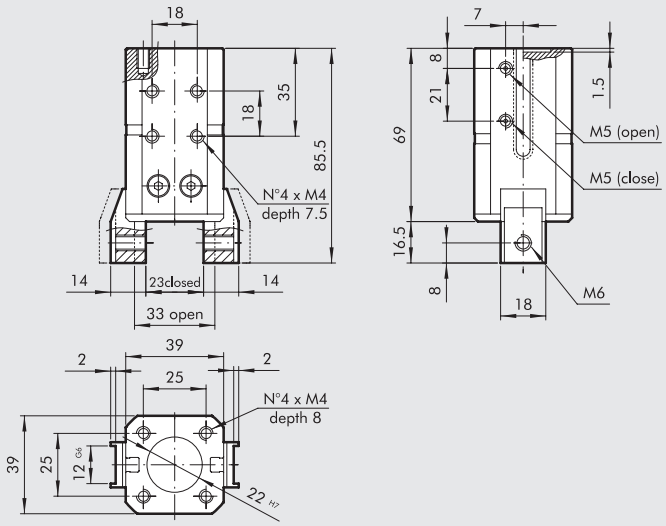
TECHNICAL DATA		P1-20	P1-32
Operating pressure	bar	2 to 8	
	MPa	0.2 to 0.8	
	psi	29 to 116	
Temperature range	°C	5 to 70	
Fluid		20 µm filtered, lubricated or unlubricated air; lubrification if used, it must be continuous	
Bores	mm	20	32
Clamping force at 6.3 bar 20 mm from the top surface	N	70	170
during opening and closing			
Single jaw stroke	mm	5	5
Weight	kg	0.50	0.70

TABLE OF CLAMPING FORCES FOR VARIOUS POINTS OF APPLICATION

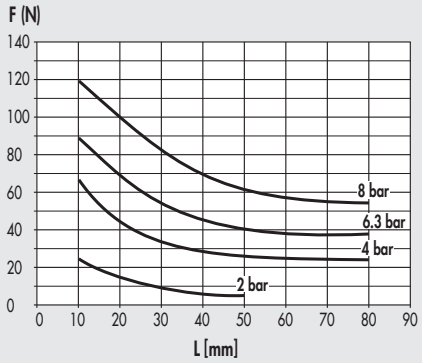


METAL WORK PNEUMATIC

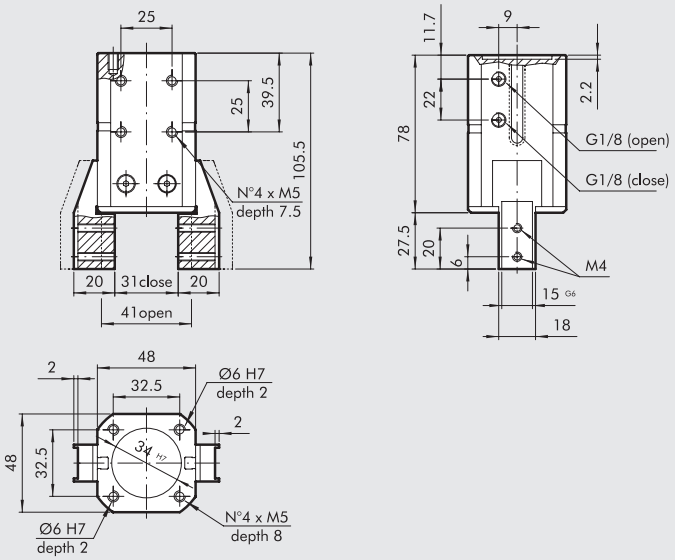
DIMENSIONS OF GRIPPER P1-20



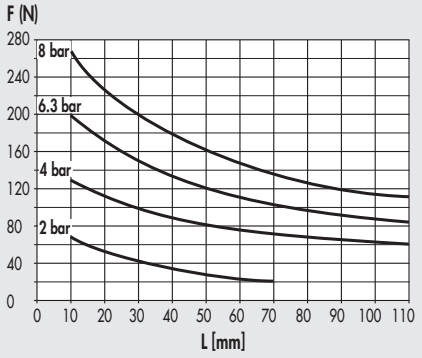
Code	Description
W1550200001	Gripper with 2 parallel jaws P1-20



DIMENSIONS OF GRIPPER P1-32



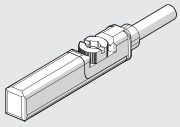
Code	Description
W1550320001	Gripper with 2 parallel jaws P1-32



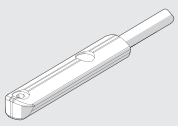
ACCESSORIES

RETRACTABLE SENSOR

SENSOR, SQUARE TYPE
Latest generation,
secure fixing



SENSOR, OVAL TYPE
Traditional



For codes and technical data, see **chapter A6**.

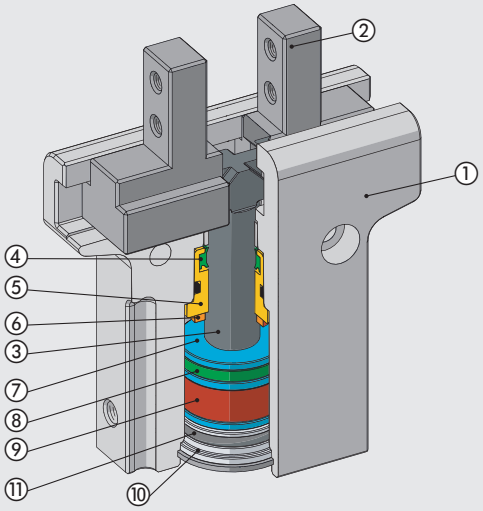
GRIPPER WITH TWO PARALLEL JAWS SERIES P2

Parallel double-acting two-jaw gripper, with either internal or external clamping, with sliding of the jaws on inclined planes.
Aluminum alloy body coated with surface hardening treatment, jaws made of wear-resistant coated steel.
The jaw-guiding system and precision in coupling with the body make the gripper extremely stable.
The ceramic-coated body reduces friction and wear, and enhances the movement of the jaws on the body.
All sizes are equipped with a magnet and sensor grooves.

TECHNICAL DATA		P2 -16	P2-20	P2- 25
Operating pressure	bar		2 to 8	
	MPa		0.2 to 0.8	
	psi		29 to 116	
Operating temperature	°C		-10 to 80	
Fluid		Fluid 20 µm filtered air, lubricated or unlubricated. If lubricated air is used, lubrication must be continuous		
Bore	mm	16	20	25
Clamping force of a single jaw	N	45	100	135
at 6.3 bar, 20 mm from the upper surface, on opening and closing				
Stroke of each jaw	mm	4	5	7
Minimum opening/closing time	s		0.01/0.02	
Repeatability	mm		± 0.01	
Moment of inertia around the piston axis Jy	kg cm²	0.19	0.83	2.33
Max. admissible static loads:				
- Fa	N	225	300	545
- Mx	Nm	3	4	7
- My	Nm	1.5	2	3
- Mz	Nm	3.5	5	8
Weight	kg	0.13	0.27	0.51

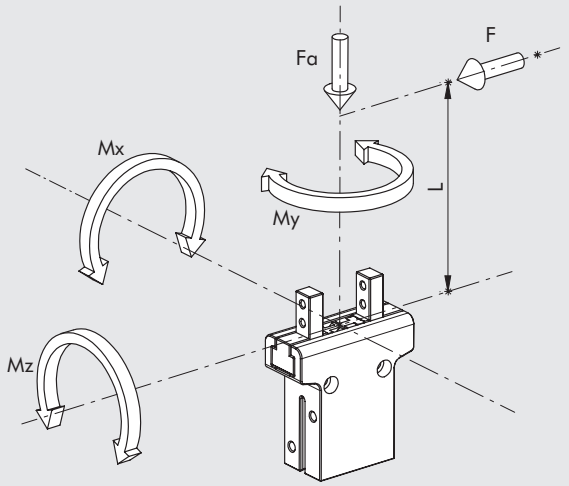
COMPONENTS

① BODY: hard-anodized aluminium
② JAWS: nitrided steel
③ PISTON ROD + GUIDE: nitrided steel
④ PISTON ROD GASKET: polyurethane
⑤ BUSHING: bronze
⑥ BUFFER: polyurethane
⑦ PISTON: aluminium alloy
⑧ PISTON GASKET: NBR
⑨ MAGNET: plastoferrite
⑩ REAR BASE: anodized aluminium alloy
⑪ GASKET: NBR



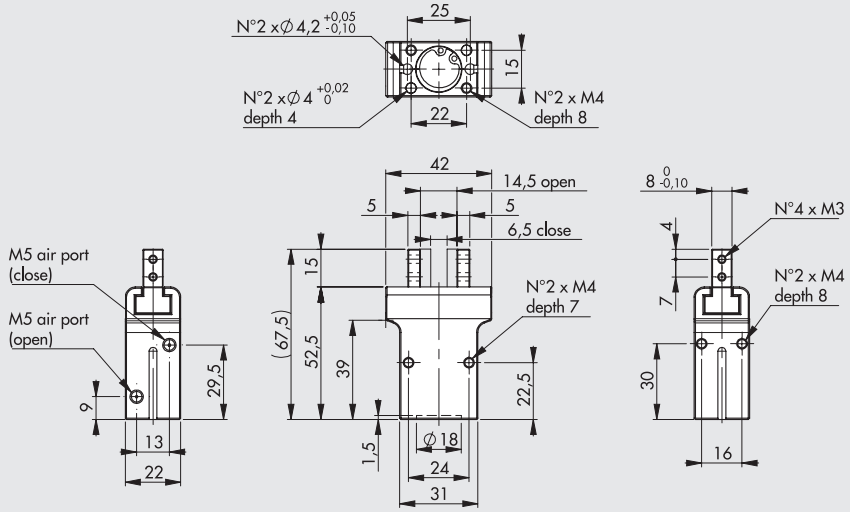
METAL WORK PNEUMATIC

DIAGRAM OF FORCES AND MOMENTS

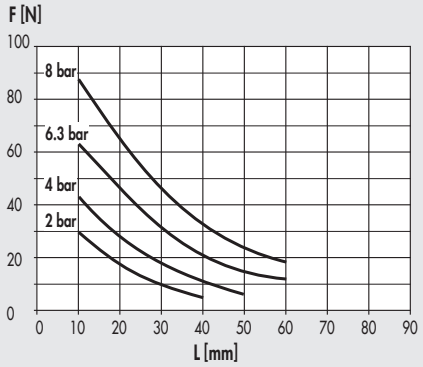


F	Clamping force for each jaw
Fa	Maximum static axial force
Mx, My, Mz	Maximum static moments

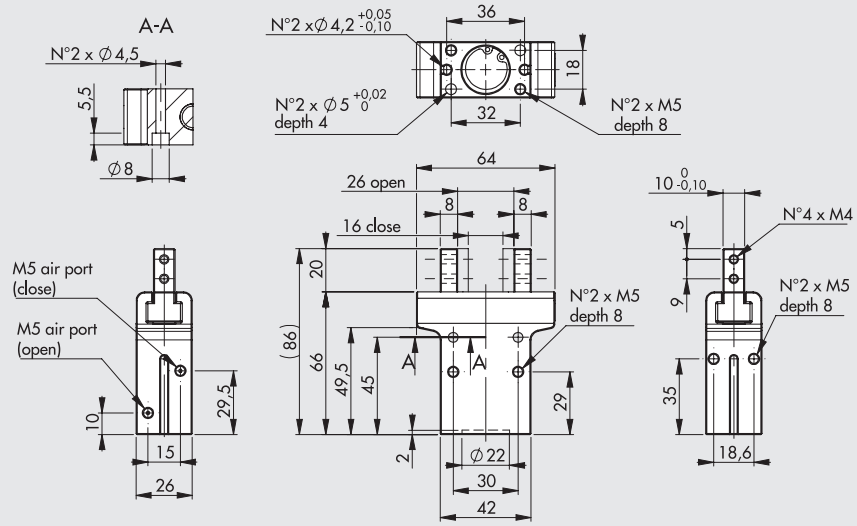
DIMENSIONS OF GRIPPER P2-16



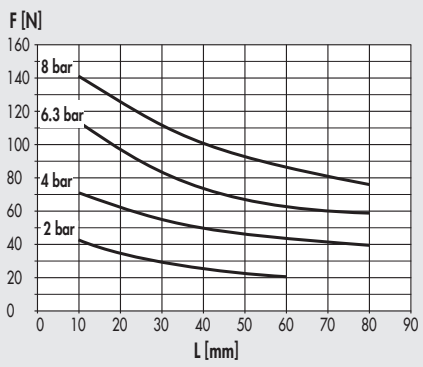
Code	Description
W1570160200	Gripper with 2 parallel jaws P2-16



DIMENSIONS OF GRIPPER P2-20

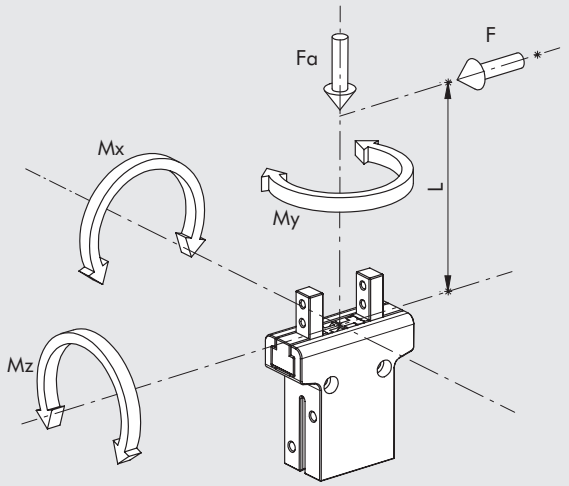


Code	Description
W1570200200	Gripper with 2 parallel jaws P2-20



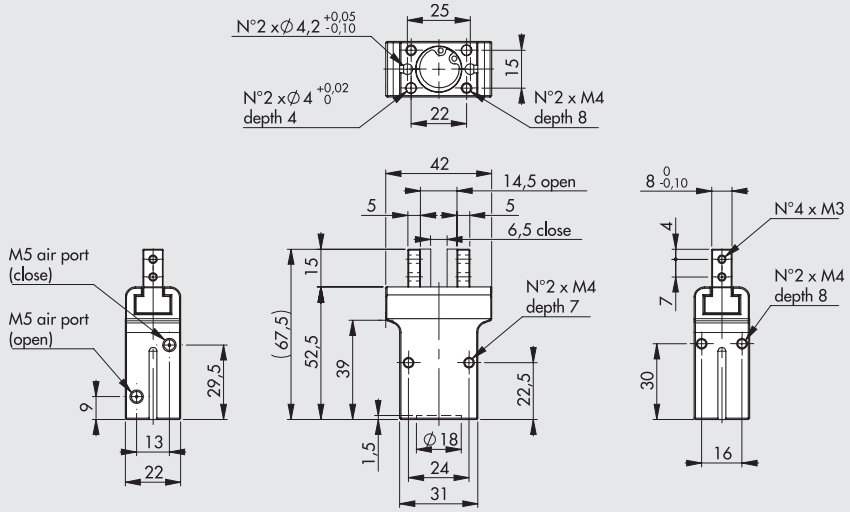
METAL WORK PNEUMATIC

DIAGRAM OF FORCES AND MOMENTS

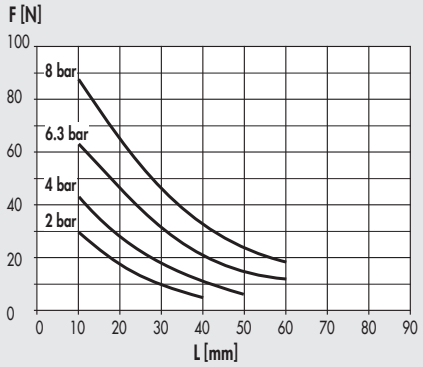


F	Clamping force for each jaw
Fa	Maximum static axial force
Mx, My, Mz	Maximum static moments

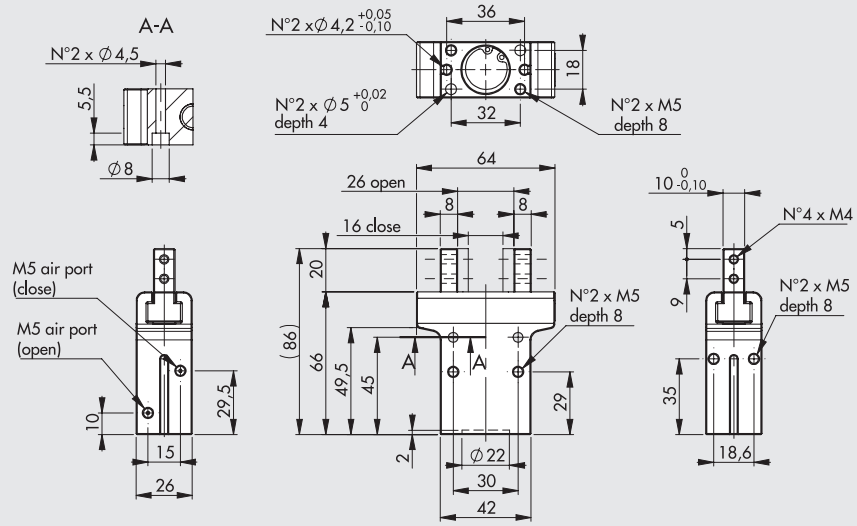
DIMENSIONS OF GRIPPER P2-16



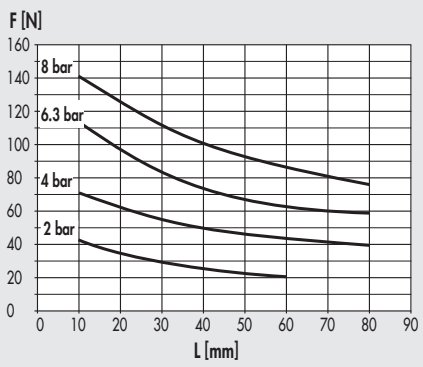
Code	Description
W1570160200	Gripper with 2 parallel jaws P2-16



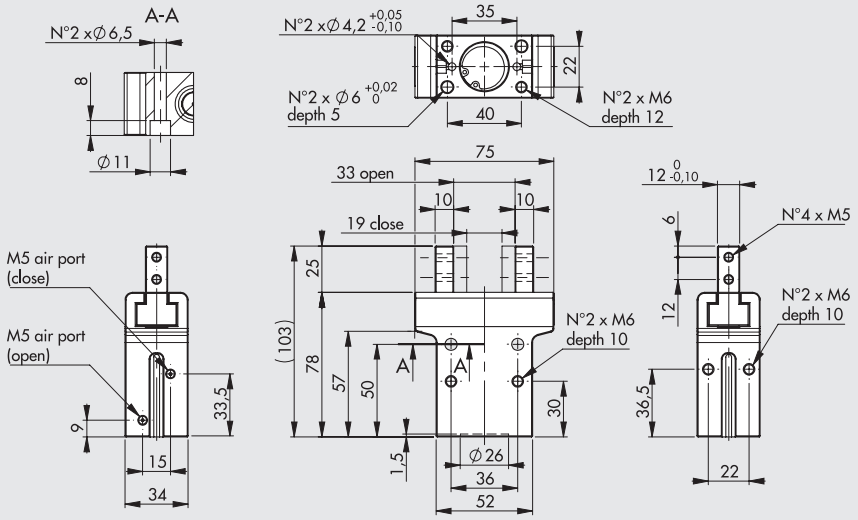
DIMENSIONS OF GRIPPER P2-20



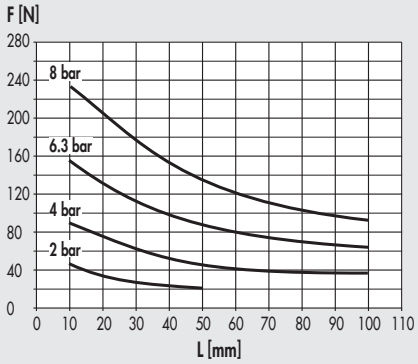
Code	Description
W1570200200	Gripper with 2 parallel jaws P2-20



DIMENSIONS OF GRIPPER P2-25

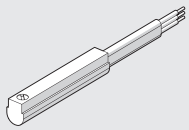


Code	Description
W1570250200	Gripper with 2 parallel jaws P2-25



ACCESSORIES

SENSOR Ø 4



For codes and technical data, see **chapter A6**.

NOTES

GRIPPER WITH TWO PARALLEL JAWS, SERIES P3

Parallel double-acting two-jaw gripper, with either internal or external clamping.
Aluminum alloy body coated with surface hardening treatment; jaws made of wear-resistant coated steel.
The jaw-guiding system and precision in coupling with the body make the gripper extremely stable.
The ceramic-coated body reduces friction and wear, and enhances the movement of the jaws on the body.
All sizes are available in the version with standard stroke and clamping force, while only some in the version with reduced stroke but with higher clamping torque.
The gripper is equipped with a magnet and grooves for sensors.
A version designed to house inductive sensors is also available (**the inductive sensors are not supplied by Metal Work**).
Pneumatic supply is available on both sides.

TECHNICAL DATA		P3-40	P3-64	P3-80		P3-100	
				Standard	Increased force	Standard	Increased force
Operating pressure	bar	2 to 8					
	MPa	0.2 to 0.8					
	psi	29 to 116					
Temperature range	°C	-10 to 80					
Fluid		20 µm filtered, lubricated or unlubricated air; lubrification if used, it must be continuous					
Clamping force of a single jaw	N	75	125	265	445	360	790
at 6.3 bar, 20 mm from the upper surface, on opening and closing							
Maximum movable weight	kg	0.65	1.3	2.5	5	3.5	7
Stroke of each jaw	mm	2.5	6	8	4	10	5
Minimum opening/closing time	s	0.05					
Repeatability	mm	0.01					
Moment of inertia as regards the piston axis	kg cm²	1.8	4	4.5		12	
Max. admissible static loads:							
- Fa	N	250	1100	1500		2000	
- Mx	Nm	12	60	90		115	
- My	Nm	5	40	55		70	
- Mz	Nm	10	40	55		80	
Weight	kg	0.12	0.35	0.5		0.9	

COMPONENTS

① BODY: hard-anodized aluminium
② JAWS: nitrided steel
③ PISTON ROD + GUIDE: nitrided steel
④ PISTON: hard-anodized aluminium
⑤ PISTON GASKET: NBR
⑥ PISTON ROD GASKET: NBR / polyurethane
⑦ BASE GASKET: reinforced SBR / NBR
⑧ MAGNET: neodymium

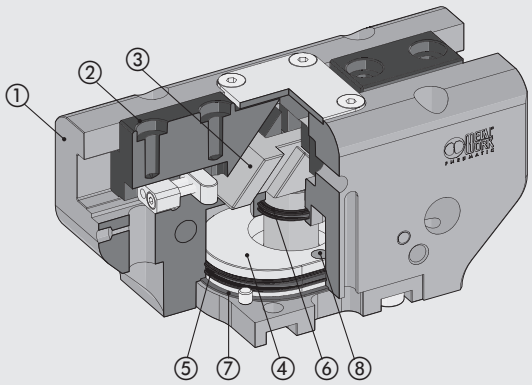
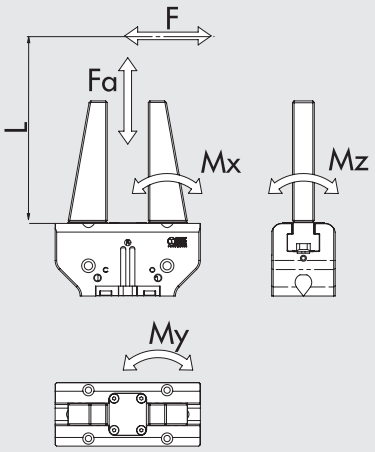
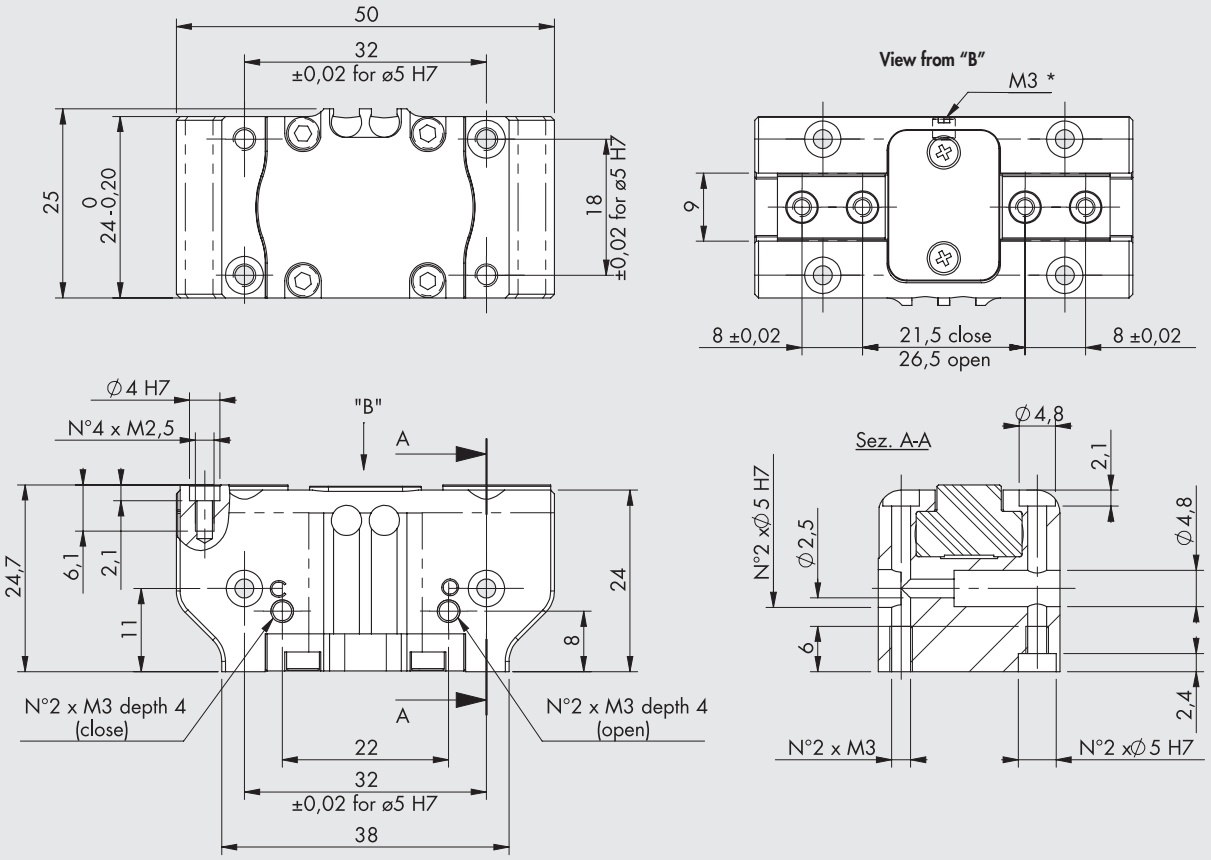


DIAGRAM OF FORCES AND MOMENTS



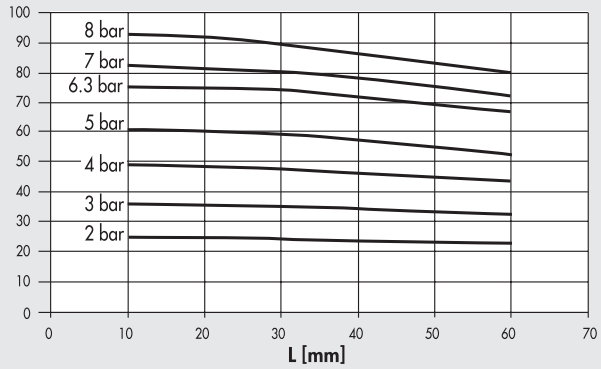
F	Clamping force for each jaw
Fa	Maximum static axial force
Mx, My, Mz	Maximum static moments

DIMENSIONS OF GRIPPER P3-40



* Discharge pressurization connection

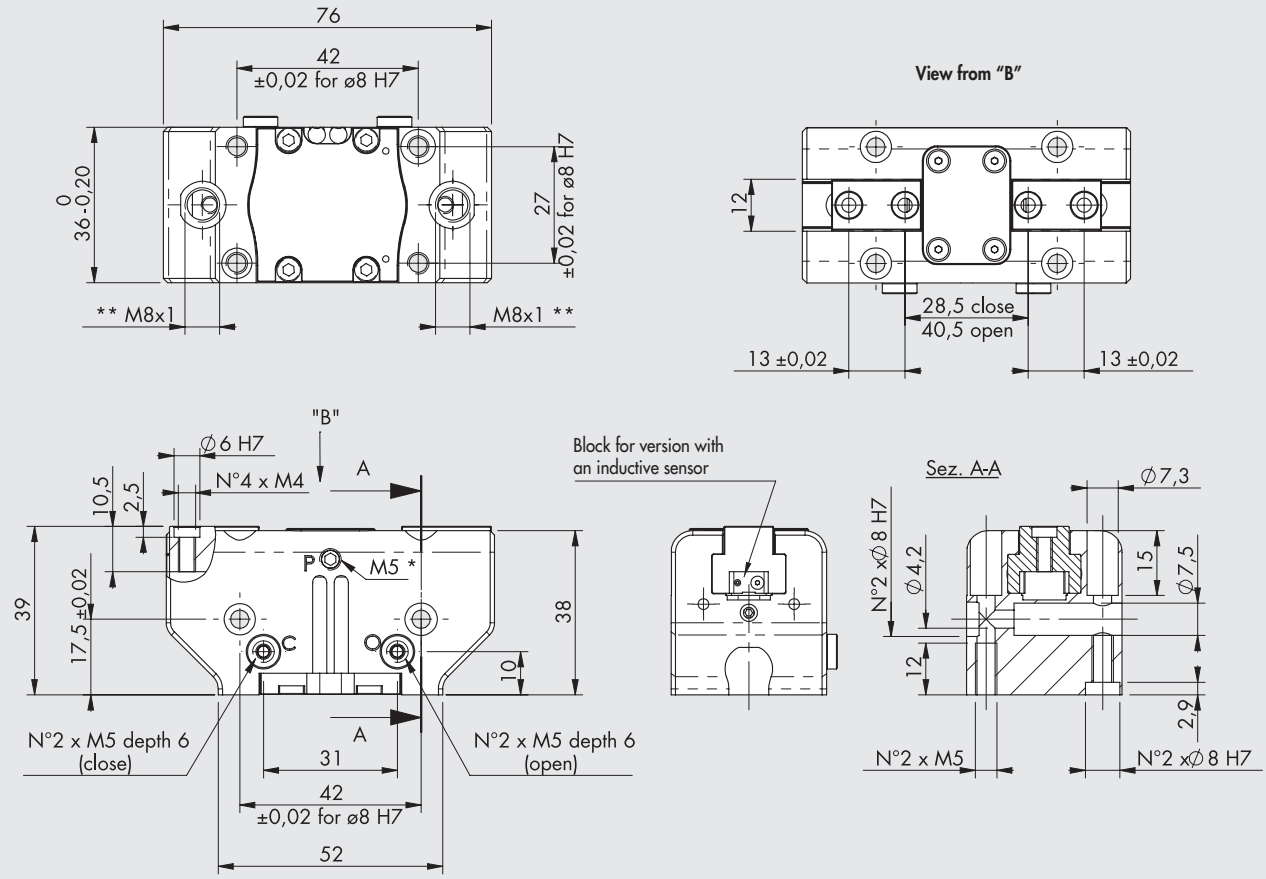
F [N]



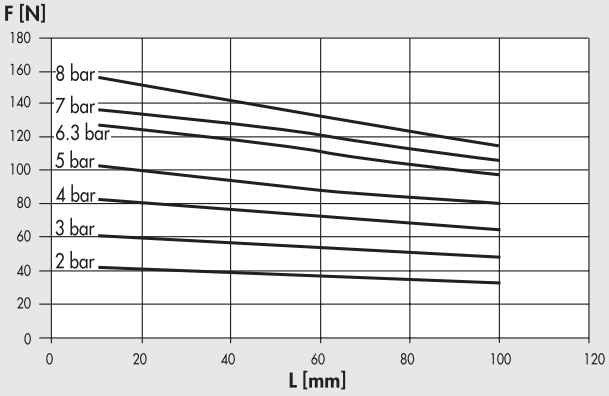
Code	Description
W1560400200	Gripper with 2 parallel jaws P3-40

METAL WORK PNEUMATIC

DIMENSIONS OF GRIPPER P3-64



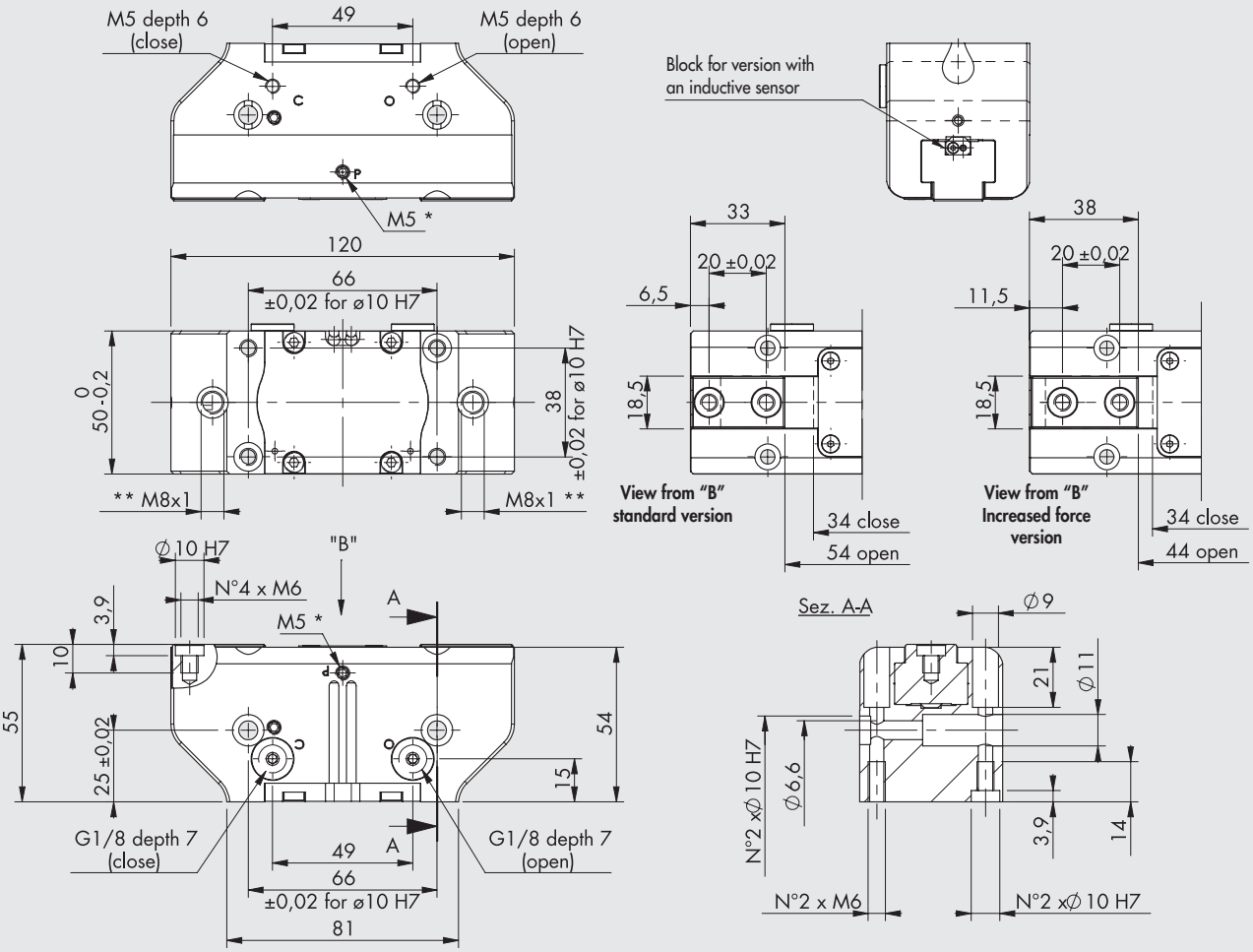
* Discharge pressurization connection, present on both sides
** Inductive sensor slot



Code	Description
W1560640200	Gripper with 2 parallel jaws P3-64
W1560640201	Gripper with 2 parallel jaws P3-64 for inductive sensors

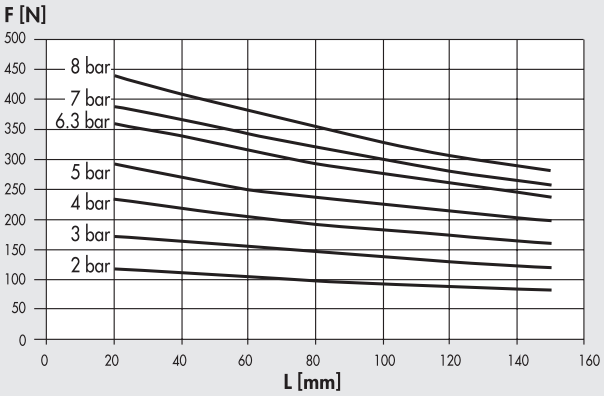
METAL WORK PNEUMATIC

DIMENSIONS OF GRIPPER P3-100

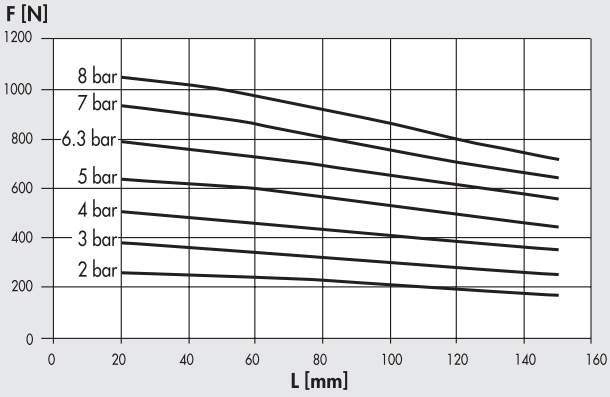


* Discharge pressurization connection, present on both sides
** Inductive sensor slot

Standard version



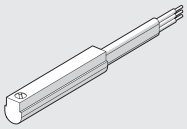
Increased force version



Code	Description
W1561000200	Gripper with 2 parallel jaws P3-100
W1561000201	Gripper with 2 parallel jaws P3-100 for inductive sensors
W1561000220	Gripper with 2 parallel jaws P3-100 increased force
W1561000221	Gripper with 2 parallel jaws P3-100 increased force for inductive sensors

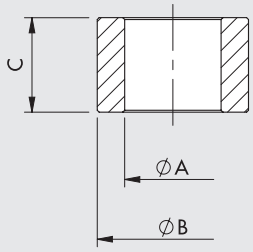
ACCESSORIES

SENSOR Ø 4



For codes and technical data, see **chapter A6**.

CENTRING RING



Code	Size	ØA	ØB f7	C
W1560409201	40	$3^{0}_{-0.1}$	4	$4^{0}_{-0.1}$
W1560649201	64	$4.5^{0}_{-0.1}$	6	$5^{0}_{-0.1}$
W1560809201	80	$5.1^{0}_{-0.1}$	8	$5^{0}_{-0.05}$
W1561009201	100	$6.2^{\pm 0.1}$	10	$6.9^{0}_{-0.1}$

Note: 2-pieces pack

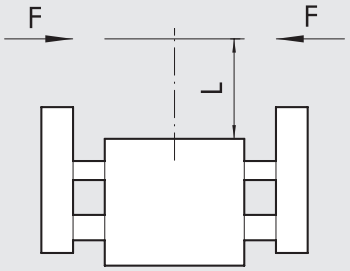
NOTES

GRIPPER WITH TWO PARALLEL LONG-STROKE JAWS, SERIES P4

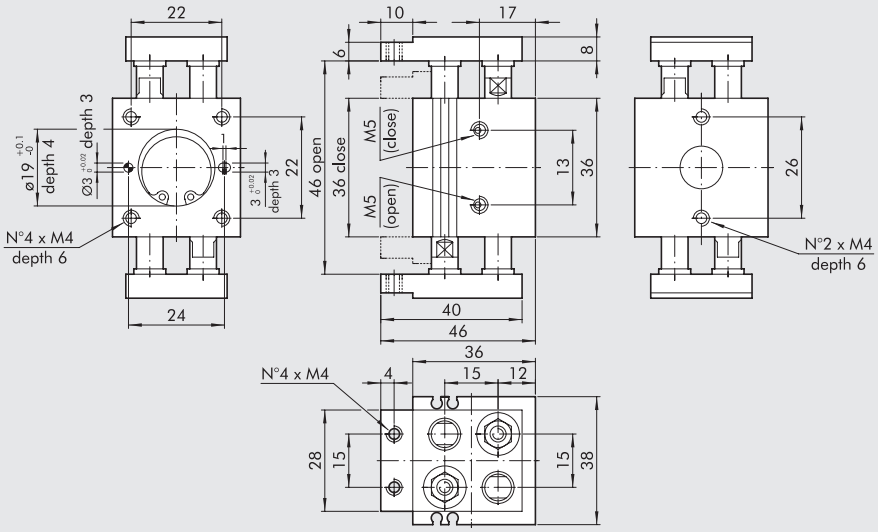
These are grippers with 2 parallel long-stroke jaws. The mechanical design makes them suitable for clamping bulky parts. All grippers, except for the smallest ones, can mount a retracting magnetic proximity sensor.

TECHNICAL DATA		P4-10	P4-12	P4-16	P4-25	P4-30
Operating pressure	bar	3 to 7				
	MPa	0.3 to 0.7				
	psi	43 to 101				
Operating temperature	°C	-10 to +80				
Maximum operating frequency	cycles/s	1				
Fluid		20 µm filtered, lubricated or unlubricated air; lubrification if used, it must be continuous				
Bore	mm	2 x 10	2 x 12	2 x 16	2 x 30	2 x 30
Single jaw stroke	mm	5	10	15	30	60
Clamping force at 6.3 bar 20 mm from the top surface during opening and closing	N	30	45	75	280	280
Weight	kg	0.18	0.3	0.5	2.95	3.7

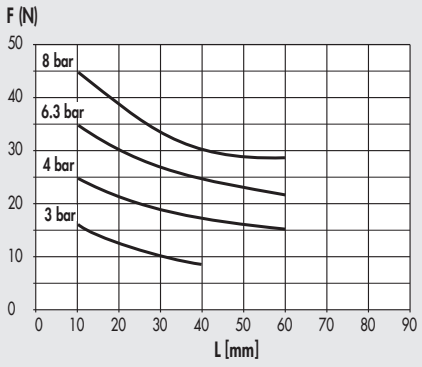
TABLE OF CLAMPING FORCES FOR VARIOUS POINTS OF APPLICATION



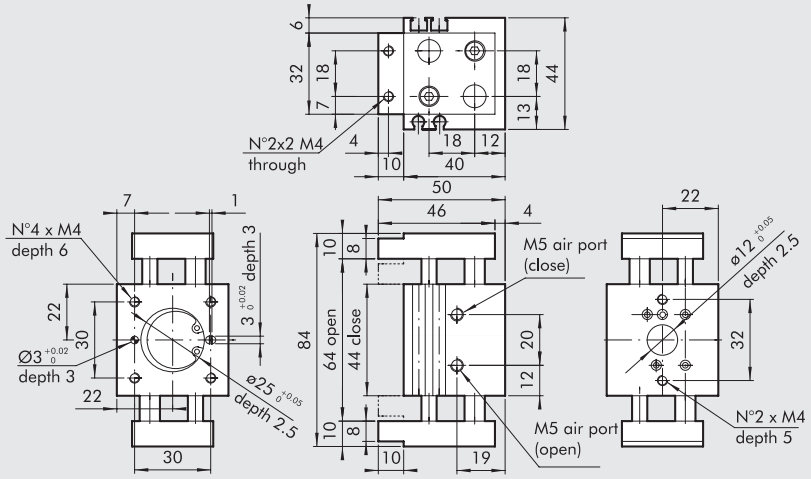
DIMENSIONS OF GRIPPER P4-10



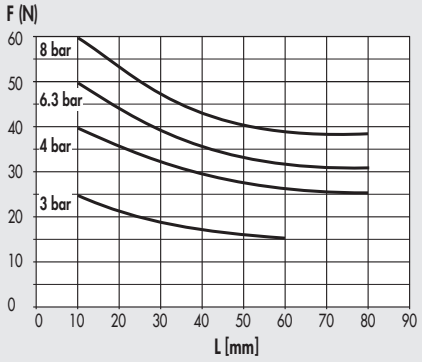
Code	Description
W1580100200	Gripper with 2 parallel long-stroke jaws P4-10



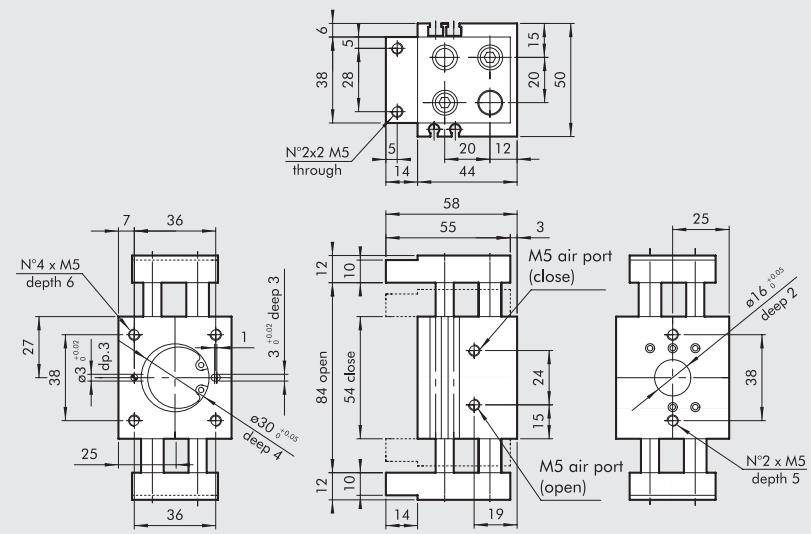
DIMENSIONS OF GRIPPER P4-12



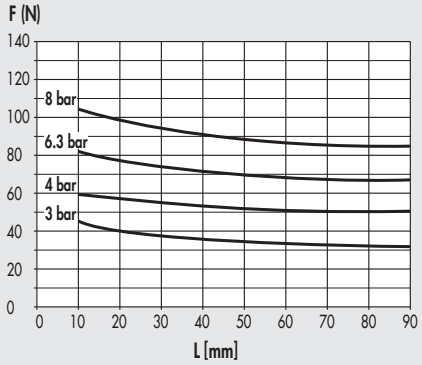
Code	Description
W1580120200	Gripper with 2 parallel long-stroke jaws P4-12



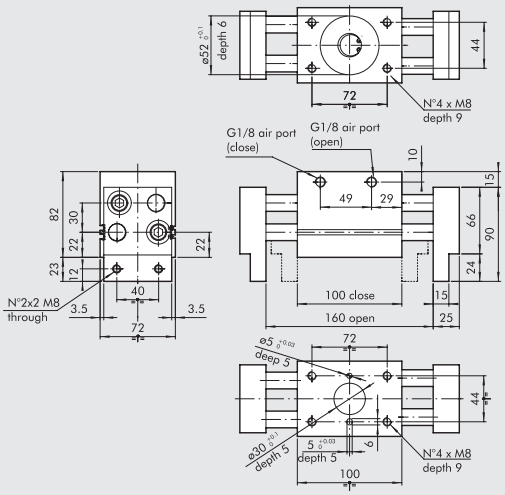
DIMENSIONS OF GRIPPER P4-16



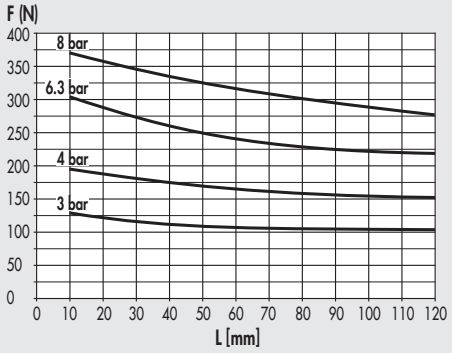
Code	Description
W1580160200	Gripper with 2 parallel long-stroke jaws P4-16



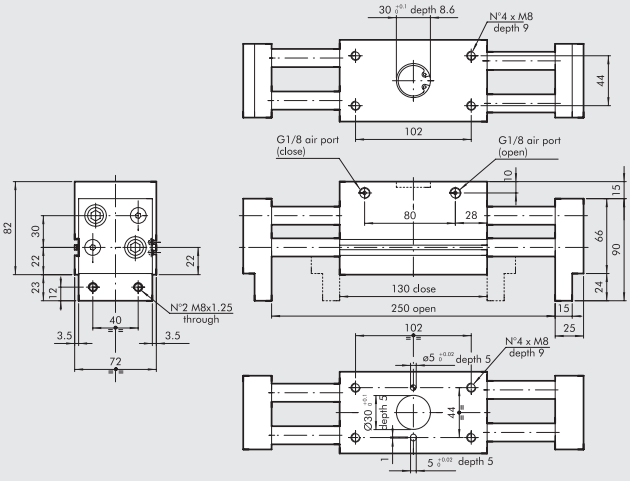
DIMENSIONS OF GRIPPER P4-25



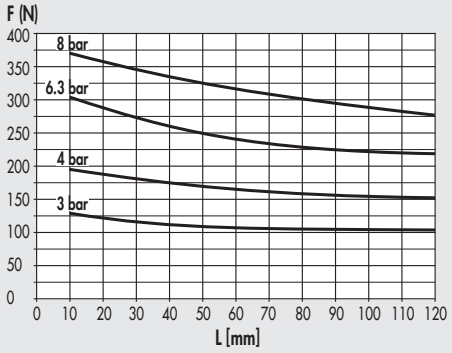
Code	Description
W1580250200	Gripper with 2 parallel long-stroke jaws P4-25



DIMENSIONS OF GRIPPER P4-30

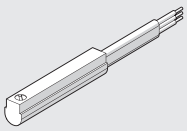


Code	Description
W1580300200	Gripper with 2 parallel long-stroke jaws P4-30



ACCESSORIES

SENSOR Ø 4 FOR P4 10-30

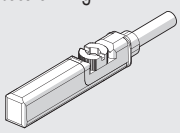


For codes and technical data, see **chapter A6**.

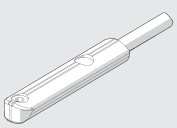
RETRACTABLE SENSOR FOR P4-12-30

For codes and technical data, see **chapter A6**.

SENSOR, SQUARE TYPE
Latest generation, secure fixing

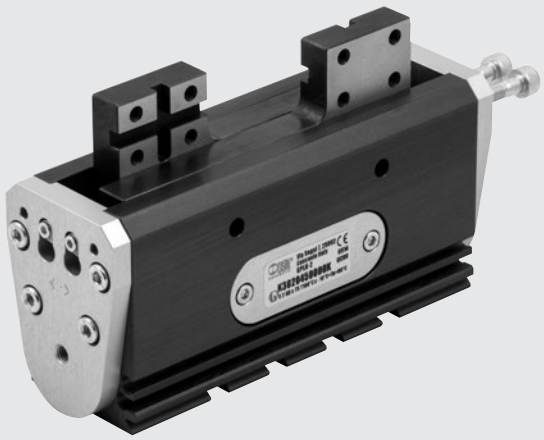


SENSOR, OVAL TYPE
Traditional



GRIPPER WITH TWO PARALLEL LONG-STROKE JAWS, SERIES GPLK

Dual-acting parallel grippers with either internal or external clamping.
The long stroke make them ideal for clamping parts of different sizes or when the clamping fingers are specifically shaped to hold the part.
The jaw guide is particularly sturdy and is designed to reduce friction and backlash to a minimum, which is a guarantee of long life.
The body is made of hard-anodized aluminium.
The jaws are made of high-tensile hardened and ground steel.
The pistons are housed in a stainless steel jacket.
The end-of-stroke position both on opening and closing can be adjusted using the screws positioned on one side. The grippers come with magnetic or inductive sensors to read the end-of-stroke position.
The magnetic sensors are housed in grooves on the side of the body.
Inductive sensors are inserted into holes on one side.
The side of the body opposite the jaws has a V-Lock profile and grooves.
It is advisable to use flow regulators to control the opening and closing speed and prevent end-of-stroke impacts.



TECHNICAL DATA		GPLK-1-30	GPLK-1-40	GPLK-2-45	GPLK-2-60	GPLK-2-75
Operating pressure	bar	2 to 8				
	MPa	0.2 to 0.8				
	psi	29 to 116				
Temperature range	°C	-10 to 80				
Fluid		20 µm filtered air, lubricated or unlubricated. If lubricated air is used, lubrication must be continuous				
Clamping force of a single jaw	N	42		116		
at 6.3 bar, 20 mm from the upper surface, on opening and closing						
Single jaw stroke, adjustable	mm	1 to 15	6 to 20	5.5 to 22.5	13 to 30	20 to 37.5
Maximum overall stroke	mm	30	40	45	60	75
Minimum opening/closing time						
measured at maximum stroke:						
at 3 bar	s	0.18	0.22	0.44	0.60	0.76
at 6 bar	s	0.10	0.12	0.28	0.32	0.36
Repeatability (on 100 strokes at constant conditions)	mm	< 0.03			< 0.04	
Moment of inertia around the y axis	kg.cm²	3.5	4.4	16.4	21.5	29.1
Weight	kg	0.44	0.46	1.04	1.12	1.26
Max. admissible static loads						
Ft	N	7.5			15	
Fa	N	70			120	
Mx	Nm	9			37	
My	Nm	4			23	
Mz	Nm	7			22	

COMPONENTS

① BODY: hard-anodized aluminium
② ROLLER: tempered steel
③ BLANKING PLATE: blank anodized aluminium
④ STOP PLATE: blank anodized aluminium
⑤ INTERNAL BODY: steel
⑥ PINION: nitrided steel
⑦ MAGNET: neoplast
⑧ PISTON: technopolymer
⑨ GASKET: NBR
⑩ RACK: burnished steel
⑪ JAW: tempered steel

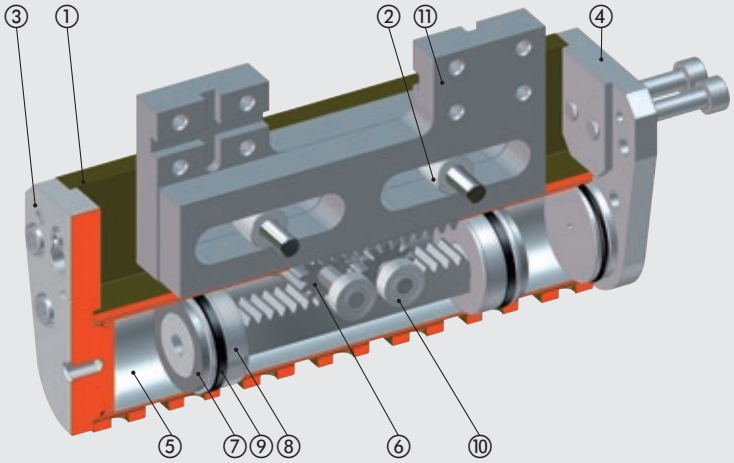
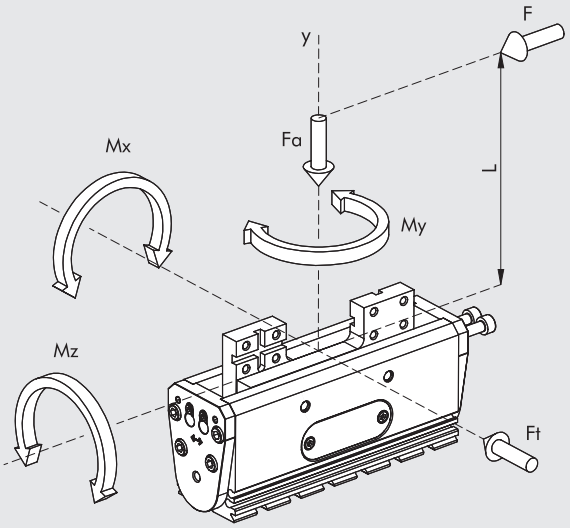
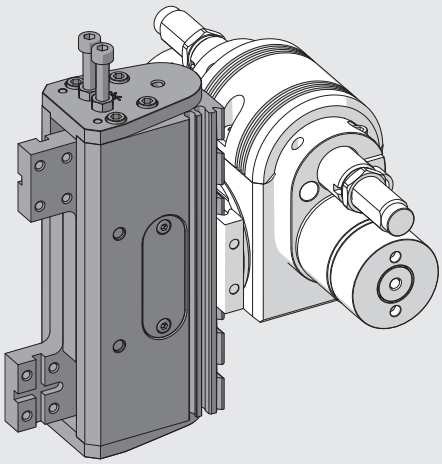


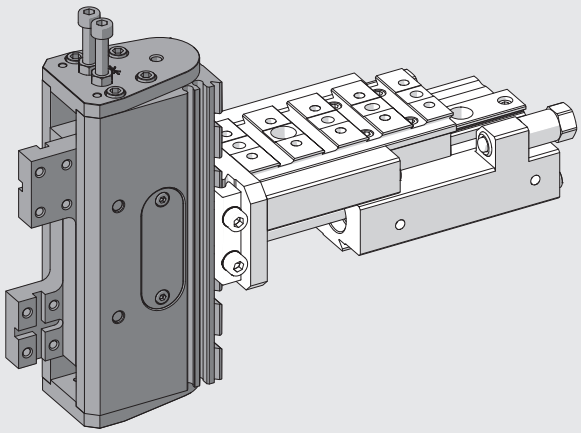
DIAGRAM OF FORCES AND MOMENTS



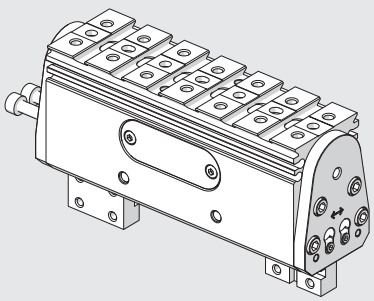
F	Clamping force
Ft	Maximum static traverse force
Fa	Maximum static axial force
Mx, My, Mz	Maximum static moments

EXAMPLES OF APPLICATION

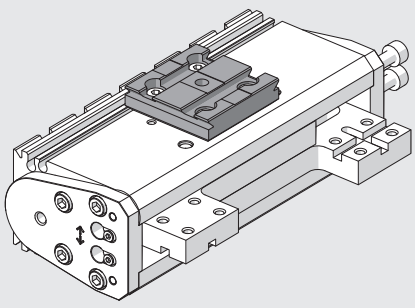




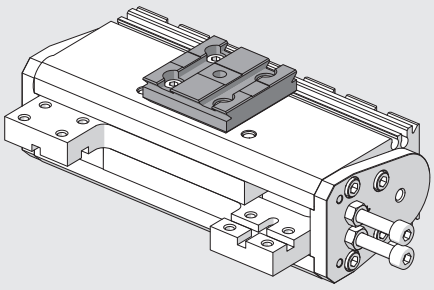
V-Lock MOUNTING OPTIONS



Gripper as supplied



Fix the accessory "type 2 side adaptor" code 0950008004K, lengthwise

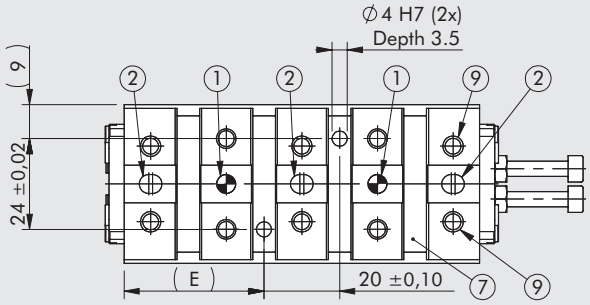


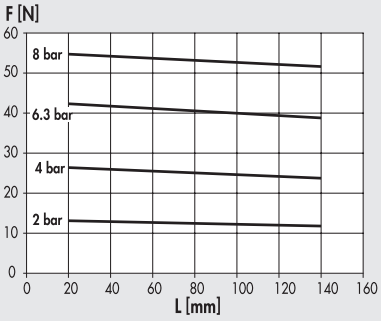
Fix the accessory "type 2 side adaptor" code 0950008004K, crosswise

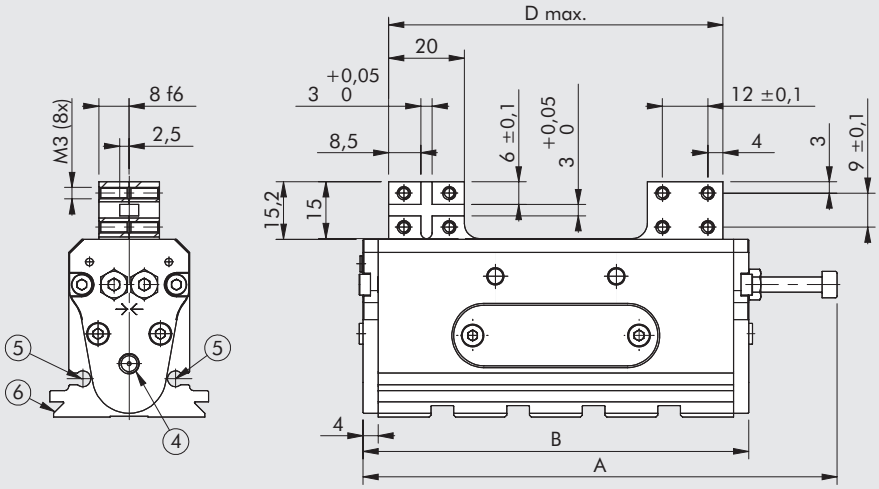
METAL WORK PNEUMATIC

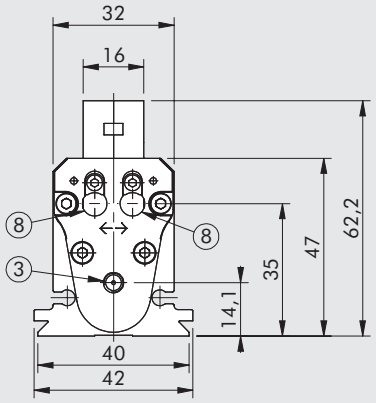
DIMENSIONS OF GRIPPER GPLK-1

① Holes for centring pins (Ø5H7 depth 2.5)
② Centring slot (Ø5H7 depth 2.5)
③ Gripper opening power (M5)
④ Gripper closing power (M5)
⑤ Magnetic sensor fixing slots
⑥ Dovetail for "V-Lock" fixing. For standard dimensions, see **chapter V-Lock adaptors**
⑦ Slot for "V-Lock" precision key
⑧ Inductive induction sensor slot
⑨ Threaded holes for fixing (max depth 4.5)

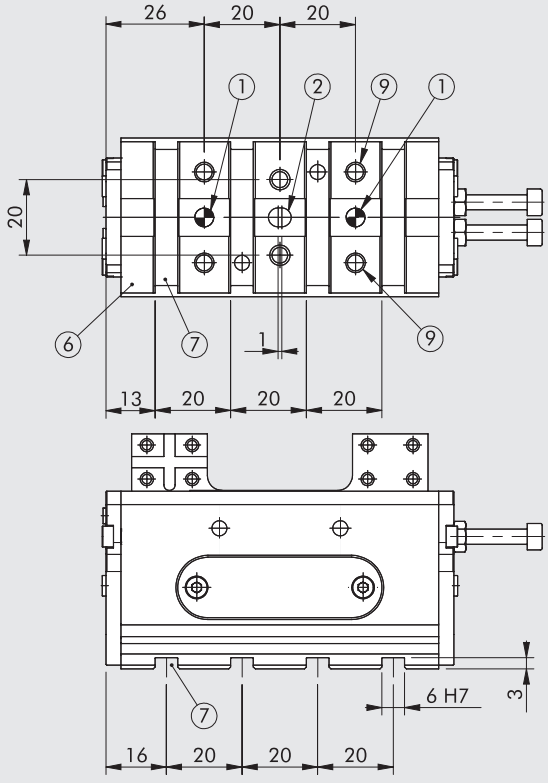




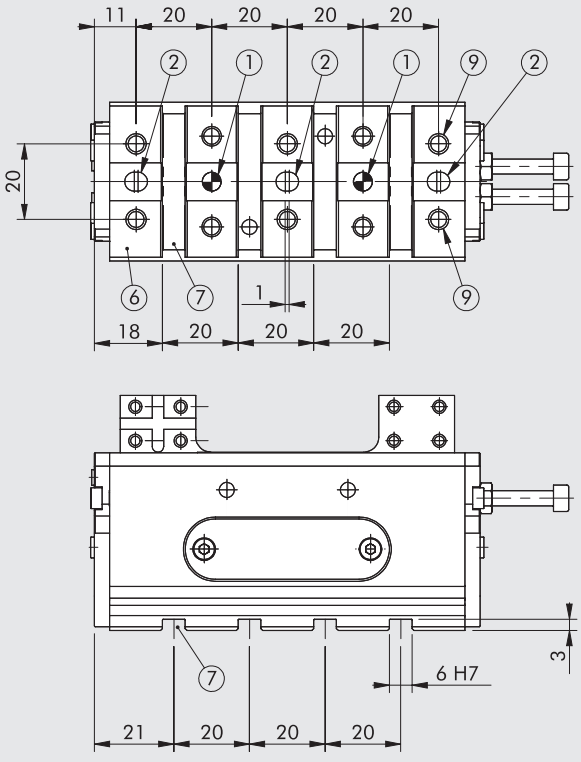




GPLK-1-30



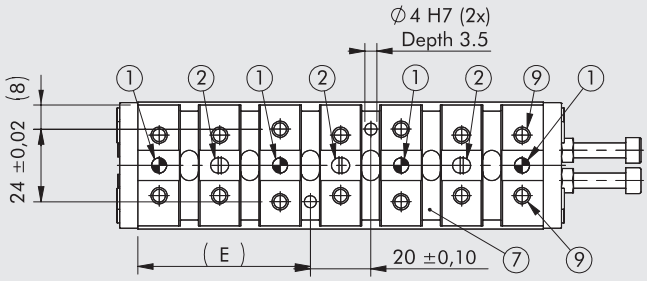
GPLK-1-40

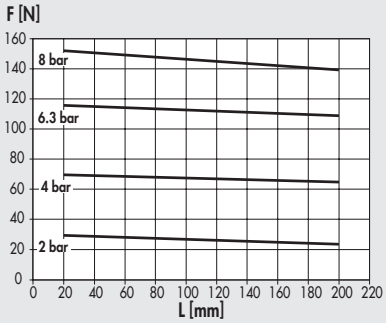


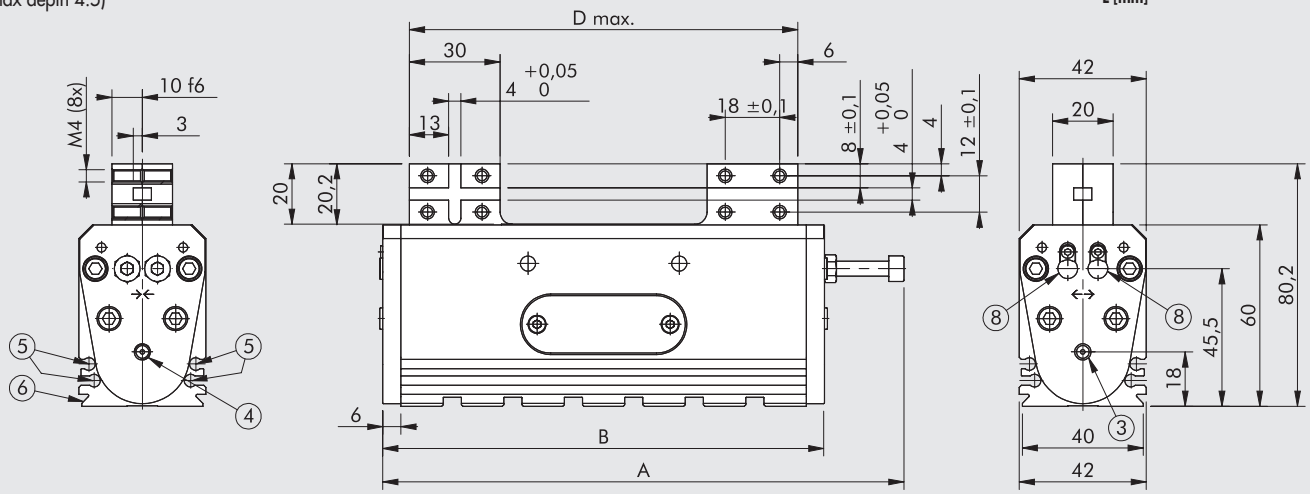
Code	Description	Overal Stroke	A	B	D max	E
K3010300000K	GPLK-1-30	30	114	92	78	32
K3010400000K	GPLK-1-40	40	124	102	88	37

DIMENSIONS OF GRIPPER GPLK-2

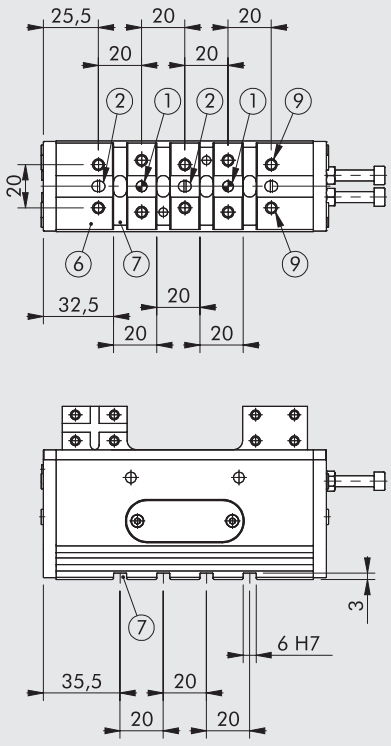
① Holes for centring pins (Ø5H7 depth 2.5)
② Centring slot (Ø5H7 depth 2.5)
③ Gripper opening power (M5)
④ Gripper closing power (M5)
⑤ Magnetic sensor fixing slots
⑥ Dovetail for "V-Lock" fixing. For standard dimensions, see **chapter V-Lock adaptors**
⑦ Slot for "V-Lock" precision key
⑧ Inductive induction sensor slot
⑨ Threaded holes for fixing (max depth 4.5)



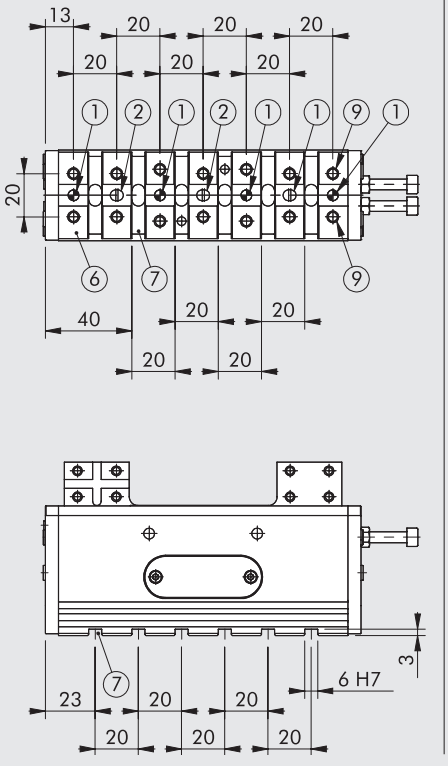




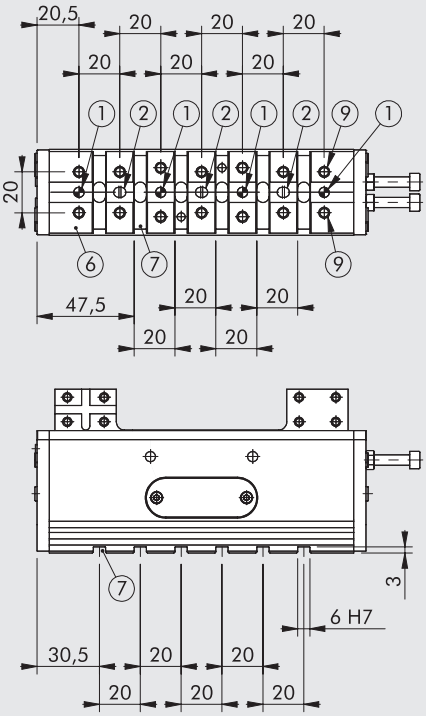
GPLK-2-45



GPLK-2-60



GPLK-2-75



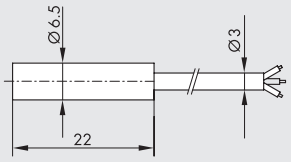
Code	Description	Overal Stroke	A	B	D max	E
K3020450000K	GPLK-2-45	45	157	131	113	49.5
K3020600000K	GPLK-2-60	60	172	146	128	57
K3020750000K	GPLK-2-75	75	187	161	143	64.5

ACCESSORIES

V-Lock ACCESSORIES

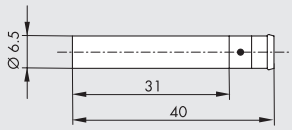
See page **A3**.36

INDUCTION SENSOR Ø 6.5



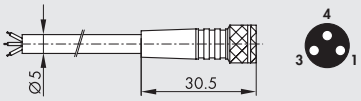
Code	Description
W095K030006	PNP Ø 6.5 PNP inductive sensor with LED 2 m
W095K031006	NPN Ø 6.5 NPN inductive sensor with LED 2 m

QUICK-FIT INDUCTIVE SENSOR Ø 6.5



Code	Description
W095K030009	PNP Ø 6.5 inductive sensor with push-in LED

CABLE WITH STRAIGHT CONNECTOR FOR Ø 6.5 PUSH-IN INDUCTIVE SENSOR (MOBILE INSTALLATION)

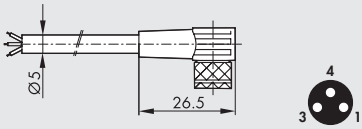


Pin	Cable color
1	Brown
3	Blue
4	Black

Code	Description
02400A0100	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 1 m
02400A0250	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 2.5 m
02400A0500	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 5 m
02400A1000	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 10 m

Note: Mobile laying cable, class 6 according to IEC 60228

CABLE WITH 90° CONNECTOR FOR Ø 6.5 PUSH-IN INDUCTIVE SENSOR (MOBILE INSTALLATION)

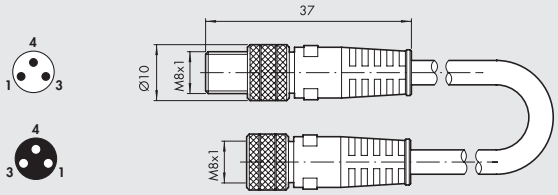


in	Cable color
1	Brown
3	Blue
4	Black

Code	Description
02400B0100	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 1 m
02400B0250	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 2.5 m
02400B0500	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 5 m
02400B1000	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 10 m

Note: Mobile laying cable, class 6 according to IEC 60228

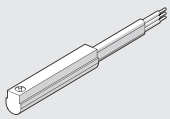
M8 M – M8 F CONNECTOR FOR Ø 6.5 PUSH-IN INDUCTIVE SENSOR (MOBILE INSTALLATION)



Code	Description
0240009009	M8-M8 3-pin straight connector with cable L = 3 m

Note: Can be used for direct connection to the modules with digital INPUT of the EB 80 and CM valves

SENSOR Ø 4



For codes and technical data, see **chapter A6**.

OIL

Code	Description	Volume
9910490	PARALIQ P 460	80 ml