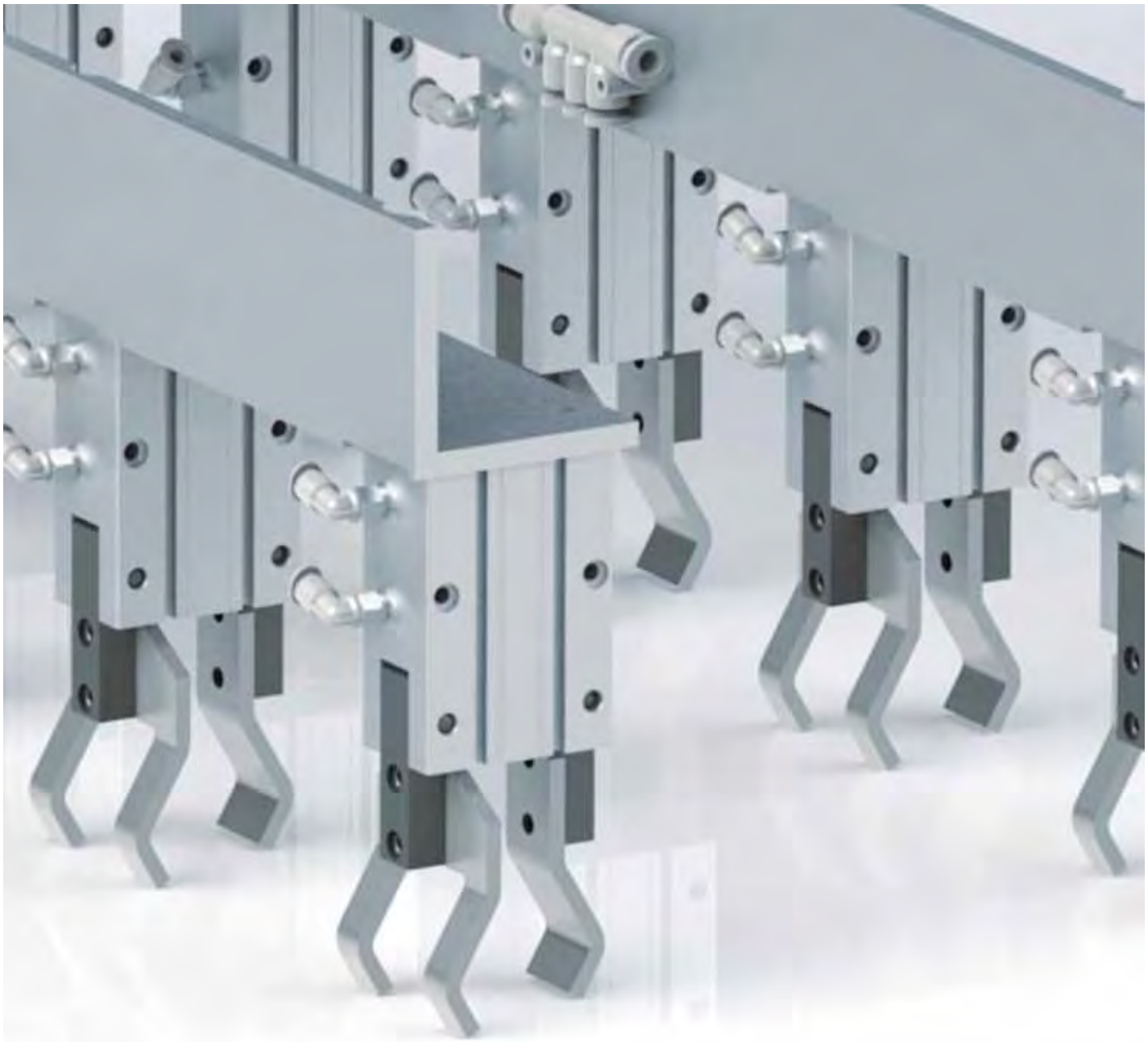
Rexroth
Bosch Group

Mechanical Gripper Technology for Handling – custom-made by Rexroth



A precise grasp, secure hold, and perfect release – utter mastery

There's a reason that jugglers and magicians are admired and revered on stages around the world. They are masters of complex movement. Their speed and precision send chills down our spines; their skill and dexterity leave us breathless. At Rexroth, our approach is similar – we've just done away with the smoke and mirrors.

Get the perfect grip. With Rexroth

The right gripping technology for every task
Grippers are essentially the “hands” of automation technology. They carry out the final functions in a handling system and make direct contact with the workpiece. The specific type, form, and properties of the transported workpiece are thus key criteria in the selection and configuration of gripper technology. The diversity of products, workpieces, and movement applications needs to be met by matching solutions for handling. Get a solid grip on your application, with Rexroth handling solutions.

- Gripper technology precisely tailored to the application
- Gripper product range for a large variety of handling needs
- Optimum integration of individual products and components in complete automation solutions

Industry expertise
Our combination of technological and industry expertise makes all the difference. Together with our customers, we have expanded on our know-how and developed a product portfolio that is precisely tailored to meet the needs of the respective industry. The result? Products, systems, and complete solutions that are best in class in all respects and exactly fit your purpose. Talk to one of our industry experts available throughout the world.

Whether gentle and sensitive or robust and powerful – our product range covers all your needs. High-quality components paired with application-specific know-ledge and cross-systems expertise.

Mechanical grippers – for complex tasks to rival the human hand

Main gripper functions in handling applications
Grippers pick up workpieces at a specific point in a handling application, hold and transport them, and release them again with precision at a different location. Gripping, holding during movement, and releasing – what may sound simple turns out to be anything but in real technical settings. The movements need to retain the same quality, exactness and speed, for a wide variety of workpieces. This all needs to happen with gentleness and power, precision, safety, and reliability, while ensuring energy and cost-efficiency.

Technical definition of gripping:
"A gripper is the subsystem of an industrial robot which maintains a limited number of geometrically defined workpieces for a set period of time, i.e. secures the position and orientation of the workpieces in relation to the tool's or the gripper's system of coordinates. This 'secure' function is usually built up before the moving process, maintained during the moving process, and finally reversed by releasing the workpiece."

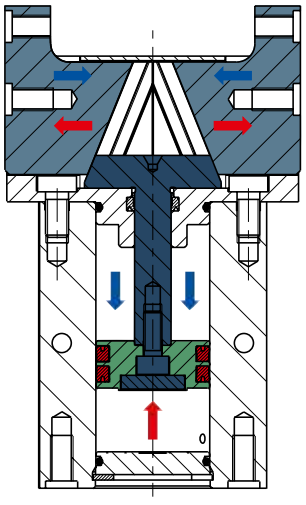
Gripper technology methods
Complex tasks inevitably result in a demand for alternative solutions. Over the years, different gripping methods have evolved with the development of automation technology.

- Vacuum gripping
- Gripping based on the Bernoulli principle
- Mechanical gripping

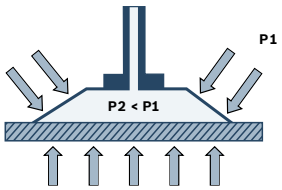
Rexroth provides well-honed automation solutions for all gripping methods
Our product range has it all, which means we can be completely objective and unbiased toward different methods whenever our customers need advice on the best handling solution for their application. We have contributed to all stages in the development of gripper technology, both vacuum and mechanical, and can also claim to be among the pioneers in non-contact gripping using to the Bernoulli principle. All this experience leaves its mark in our automation solutions.

Gripper technology methods

Mechanical gripping

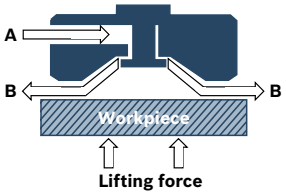


Vacuum gripping



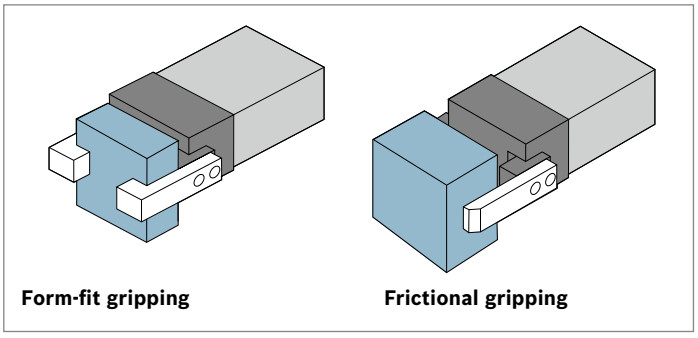
P1 = ambient pressure
P2 = vacuum pressure

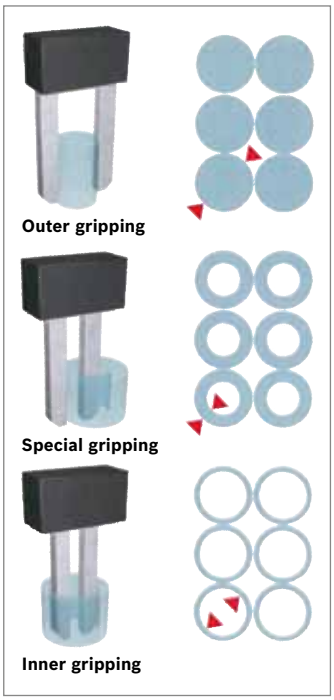
Gripping based on the Bernoulli principle

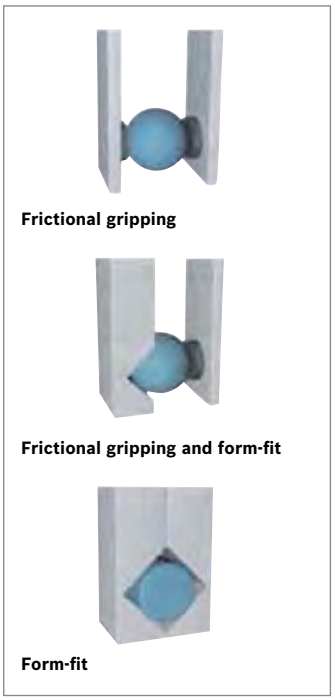


A = compressed air **B** = air flow

From the gripping principle to the right gripper concept
What is intuitive for the human hand needs to be engineered into automation technology. Important distinctions are the type and method of gripping and the design of the contact surface: from the exterior or interior, solely force-fitting, completely form-fitting, or various suitable combinations. The gripping principle is a key criterion when deciding on the right gripper type and required gripping force.



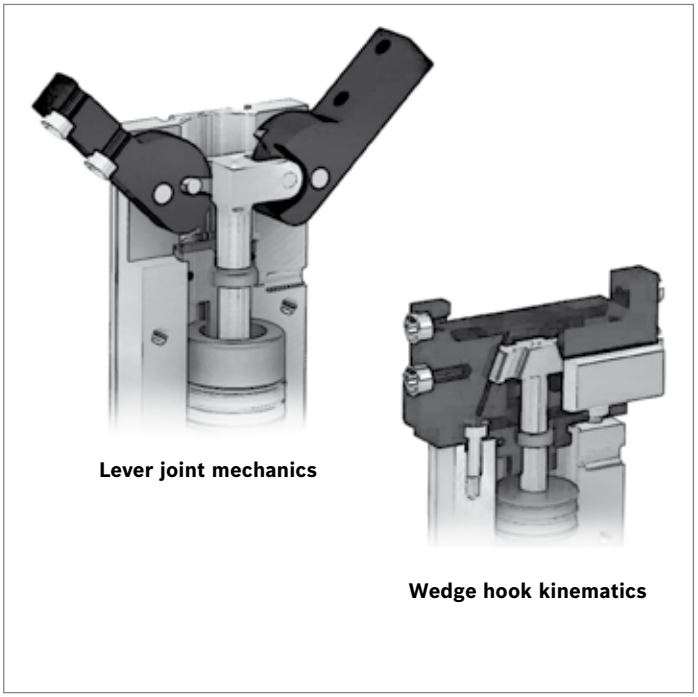


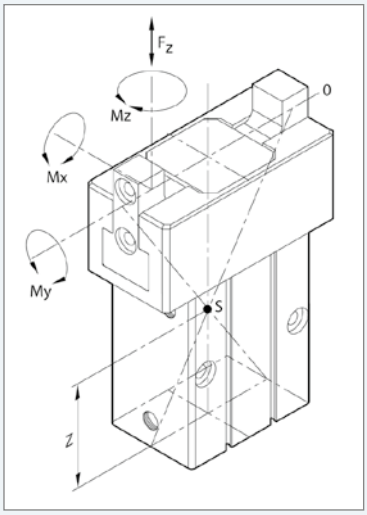


How pneumatic grippers work
Pneumatically operated mechanical grippers are driven by a piston. The conversion of the piston force into the required gripping movement and forces applied at the gripper jaws can be achieved through two different mechanisms. With lever joint mechanics, the movement is carried out by gear drives or cam disks. With wedge hook kinematics, form-fitting forces are transferred through integrated angular guides.

- Gripper force adjustable via supply pressure
- Even progression of force over the entire gripping range with wedge hook kinematics
- Low friction in the lever joints with lever mechanics

The selection of an operating principle depends on the task and functional requirements of the gripper.



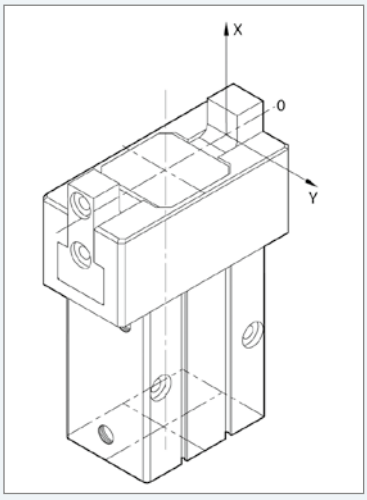


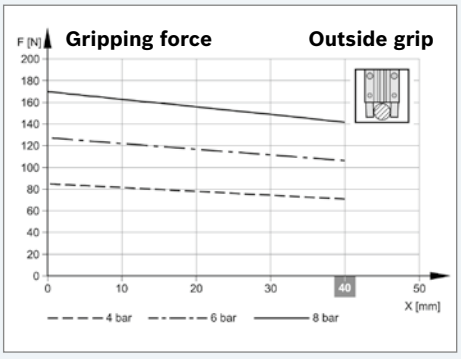
Torques and forces at the basic gripper jaws:

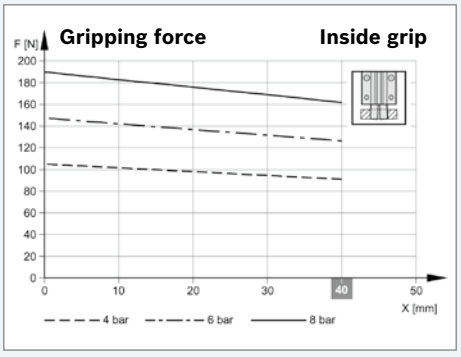
Gripping forces, gripper accelerations, and other external forces place stress on the basic jaws. The limit values for these sources of stress for the 2-finger design, parallel gripper from the GSP-P-20 series are shown in the table as an example.

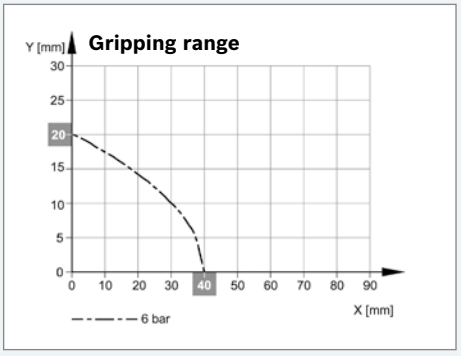
Type		GSP-P-20
Position of center of gravity	Z	41.4 mm
Maximum permissible force	F_z	250 N
Maximum torque at gripper finger	M_x	5.5 Nm
Maximum torque at gripper finger	M_y	5.0 Nm
Maximum torque at gripper finger	M_z	2.5 Nm

Maximum gripping force per gripper finger and permissible gripping range:









In addition to the gripping force, an important selection factor is the length of the gripper finger. The gripper's function is impaired and its service life shortened when the permissible values shown in the diagram are exceeded (examples for GSP-P-20).

x = clamping height
y = clamping width

Determining the friction factor μ:

When calculating the required gripping force, the friction factor is an important consideration, especially for purely frictional gripping. The table below shows the friction factor μ for frequently occurring gripper finger/workpiece combinations.

Gripper finger	Steel	Steel, forged	Aluminum	Aluminum, forged	Rubber
Steel	0.25	0.15	0.35	0.20	0.50
Steel, forged	0.15	0.09	0.21	0.12	0.30
Aluminum	0.35	0.21	0.49	0.28	0.70
Aluminum, forged	0.20	0.12	0.28	0.16	0.40
Rubber	0.50	0.30	0.70	0.40	1.0

Increased energy efficiency through an optimally dimensioned gripper configuration

Factors influencing the right gripper solution
The optimum configuration of gripper technology is a complex, application-specific task demanding due consideration of all relevant factors.

- Type of gripping and moving task
- Characteristics of the workpiece
- Operating and ambient conditions
- Machine environment

The right calculations can help to prevent overdimensioning
Precise calculations of the required force are not only critical for safe gripper operation; they also enable an energy-efficient design. The applied force – and thus energy used – is always just right.

Parallel, radial, angular, centric – it all starts with different gripper models
It's always good to have the right solution for every requirement. With four basic models, different variants and sizes, our pneumatic grippers have your automated handling application covered. Moreover, our standard range features grippers designed for unusually heavy workpieces or extremely long strokes.

Gripper configuration, horizontal movement (frictional gripping)

Minimum required gripping force F_{Gr}

$$F_{Gr} \geq \frac{\sqrt{(m_{load} \times a)^2 + (m_{load} \times g)^2}}{n \times \mu} \times S \; [N]$$

Maximum gripper torque M_Y (per gripper finger)

$$M_Y \geq \left[\frac{m_{load} \times L_{load} \times (g + a)}{n} + m_{Fi} \times L_{Fi} \times (g + a) \times S \; [Nm] \right]$$

Maximum permissible axial force F_A (per gripper finger)

$$F_A \geq \left[\frac{m_{load} \times (g + a)}{n} + m_{Fi} \times (g + a) \right] \times S \; [N]$$

m_{load} = load mass [kg]
m_{Fi} = gripper finger mass [kg]
L_{load} = load distance [m] center of jaw guide/ center of gripper finger
L_{Fi} = gripper finger distance [m] center of jaw guide/ load center
g = acceleration of gravity [9.81 m/s²]
a = max. gripper acceleration/ deceleration [m/s²]
n = number of gripper fingers
μ = friction factor
S = safety factor 1.5 to 3

Gripper fingers and the workpiece
Gripper fingers are the final element supporting the workpiece. They are individually prepared by the user for the specific workpiece and can be easily mounted on the gripper jaws and exchanged as needed.

- Form-fitting or with a frictional gripping
- Individual gripper fingers customer-made

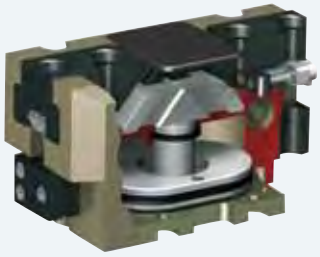
Highly diversified and proven – our range of grippers offers the right solution for every task

Whatever you need and wherever you need it! If there is a technically feasible, sound automated handling solution for your task, we will find it. With our comprehensive range of grippers, our motion technology, and our cross-systems expertise in all technologies, we hold the keys to just about every option imaginable.

Grippers based on the parallel principle
On parallel grippers, the jaws open and close in a synchronized, parallel movement, applying the clamping grip typical to this model. They are therefore suitable for applications with both inner and outer gripping.

- 2-finger, parallel gripper
- 3-finger, centric gripper
- 2-finger, parallel gripper for heavy workpieces

GSP-P series, sizes 72, 99



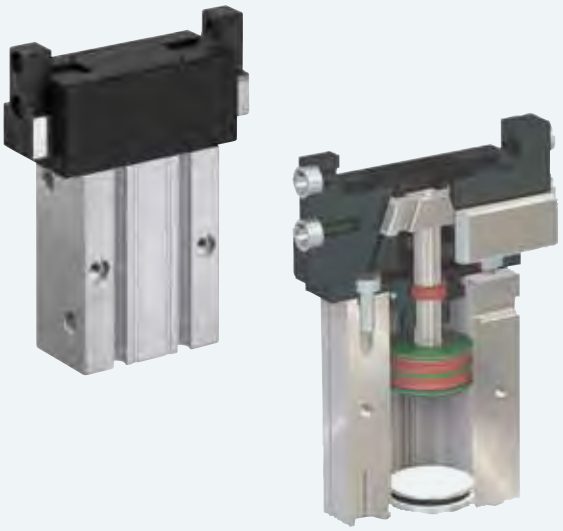
Series	GSP-P-72	GSP-P-99
Size (mm)	72	99
Total gripping force (N)	1640	2700
Max. Workpiece mass (kg)	8.2	13.5
Stroke per finger (mm)	16	25
Max. finger length (mm)	200	280

▲ **The oval piston generates the optimum volume and force. On the wedged hook, angled guides convert the piston's linear movement into the lateral, synchronous gripping movement of both basic jaws. The gripper can be mounted from two sides and secured using centering rings or pins. Compressed air is supplied via two threaded ports or via additional holes for a flange connection.**

The standard grippers for handling technology and small handling

2-finger, parallel gripper, GSP-P series
Parallel opening and closing with two fingers. Grippers from the GSP-P series are the proven standard solution for a wide variety of applications. They achieve a reliable, strong gripping force while featuring compact dimensions, high precision, and excellent repeatability. The guide housing and gripper jaws are ground to fit, thus reducing guide play to a minimum.

3-finger, centric gripper, GSP-Z series
Centric grippers hold the workpiece on three sides. The synchronous motion of the three gripper jaws via forcibly driven wedge hook kinematics provides extra gripping force, safety, and precision. The slide bearing guide exhibits virtually no play; ground-in gripper jaws in the T-slot prevent jamming, even with longer gripper fingers.



GSP-P series, sizes 08, 10, 16, 20, 25, 40

GSP-Z series, sizes 16, 32, 50

Series	GSP-P	GSP-Z
Size (mm)	08 - 40	16 - 50
Total gripping force (N)	26 - 840	120 - 1140
Max. Workpiece mass (kg)	0.13 - 4.2	0.6 - 5.7
Stroke per finger (mm)	2 - 13	3 - 7
Max. finger length (mm)	20 - 64	30 - 80

▲ **Both gripper models operate according to the same functional principle. The wedge hook kinematics convert the piston force into gripping force and motion of the gripper jaws. The robust, ground-in T-slot ensures secure and precise guiding of the jaws. All parallel grippers are double-acting and can be optionally equipped with springs for gripping safety.**

Exceptionally long strokes are their business: grippers from the GSP-P-22 and -52 series

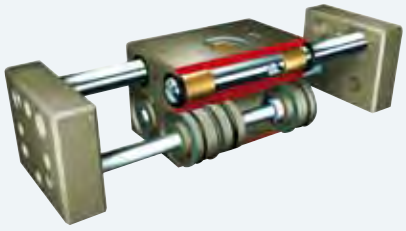
Powerful, with long strokes thanks to double pistons and rack-and-pinion kinematics

When the workpieces destined for transport exceed the standard dimensions of automated handling, our special grippers for large strokes and forces are the answer. With a broad gripping range and gripper finger lengths up to 300 mm, they ensure a secure hold and reliable movement for both large and heavy products. All this, and yet the grippers themselves practically lighten the load, thanks to light-weight aluminum alloys.

- Carrying plates for adapting tool-specific gripper fingers
- Horizontal and vertical gripper finger mounting possible
- Rack-and-pinion principle for centric clamping

Synchronous movement of the gripper jaws is achievable with minimal loss of force via two counter-running pistons.

GSP-P-22 series



Series	GSP-P-22	GSP-P-52
Size (mm)	22	52
Total gripping force (N)	320	1760
Max. Workpiece mass (kg)	1.6	8.8
Stroke per finger (mm)	28	64
Max. finger length (mm)	140	300

▲ **Pressurization of the pistons moves the basic jaws, which are mounted to the piston and the pinion. The gripper fingers are fastened to these carrying plates, either horizontally or vertically, as required. Rack-and-pinion kinematics synchronize the jaw stroke. The grippers can be mounted from two sides with a centering device. Compressed air is supplied via two threaded ports or via additional holes for a flange connection.**

Born to be different and take on special tasks: radial and angular grippers

Radial grippers, GSP-R series
Radial grippers are a good solution for applications that require a wide range of motion. They provide opening angles up to 180° and their special jaw design and cam disk mechanism allow them to achieve an optimum gripping moment and closing speed. One-piece housing and simple mechanics make these grippers sturdy and economical.

Angular grippers, GSP-A series
Highly compact, consistent repeatability. Angular grippers are the perfect choice for applications requiring opening angles up to 40°. Involute gears transfer force directly to the gripper jaws and ensure an absolutely constant gripping moment over the entire angle range.

GSP-R series, sizes 10, 16, 25, 32, 40

GSP-A series, sizes 10, 16, 25, 32, 40

Series	GSP-R	GSP-A
Size (mm)	10 - 40	10 - 40
Total gripping moment (Nm)	0.3 - 12	0.22 - 8.6
Max. Workpiece mass (kg)	0.08 - 1.15	0.08 - 0.85
Opening angle (°)	180	40
Max. finger length (mm)	25 - 80	25 - 80

▲ **The piston forces are transferred to the gripper jaws via cam disk mechanics on the radial gripper, and via a gear drive located on the piston rod on the angular gripper. Steel pins provide secure, low-friction jaw bearings, which are firmly pressed into the one-piece guide housing. All radial and angular grippers are double-acting and can be optionally equipped with springs for gripping safety.**

Because every task demands precision, repeatability, and a long service life, we make no compromises with our gripper features

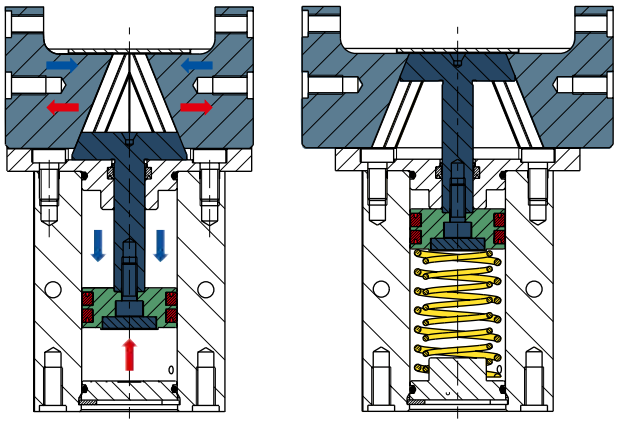
Our user-oriented practical experience and continuous product optimization are visible in every detail
When selecting the right gripper model, our customers just need to have an idea of their individual application requirements. Because in terms of quality and equipment details, we have implemented consistently high standards on all of our grippers. Whether parallel, radial, or angular grippers, the housing, basic jaws and gripper jaws are constructed of proven materials that are both sturdy and light-weight. All grippers also feature reliable and efficient movement mechanics and offer universal mounting and connection options.

- Reliable motion kinematics
- Proven materials and equipment details
- Wide variety of mounting options

And if your application requires additional performance beyond our standard equipment, we will be happy to advise you.

Versions with or without gripping safety
Independent of the respective mechanics used to transfer force, all the grippers operate with a double-acting pneumatic piston. The grippers can also be equipped with integrated springs to provide gripping safety, available in two versions depending on application requirements: open without pressure or closed without pressure.

- Functional principle: double-acting with angular kinematics
- Piston with integrated magnet
- Optional with springs for gripping safety

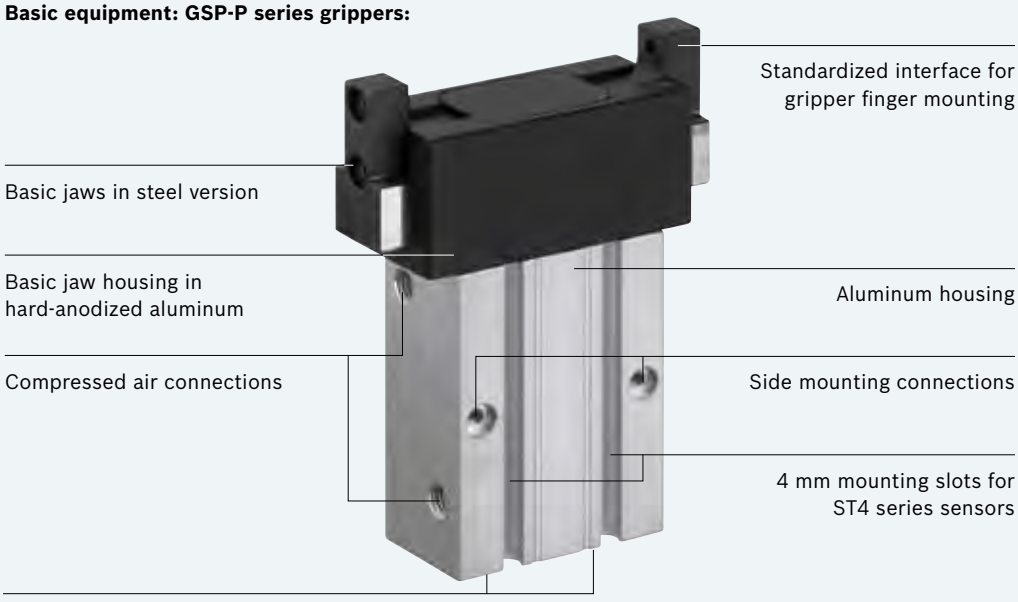


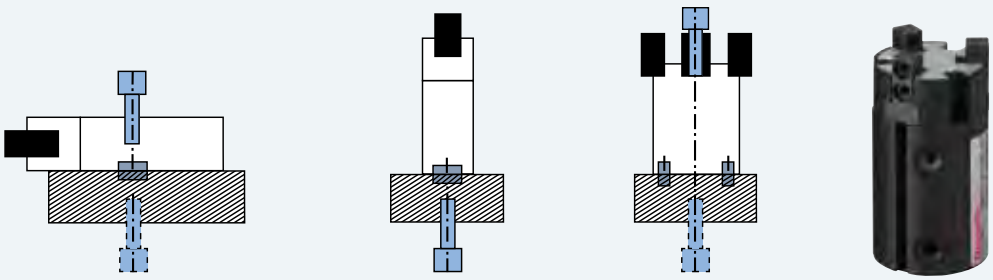
GSP-P series
Piston and gripper jaw movement with wedge hook kinematics

GSP-P series
Integrated springs for gripping safety, open without pressure

Quality, functionality, and efficiency – you get the entire package

Basic equipment: GSP-P series grippers:





GSP-P, GSP-A, GSP-R series
Gripper mounting with screws and centering rings, on the side or from below

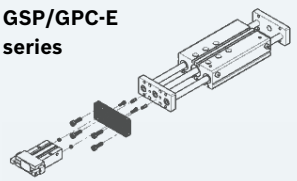
GSP-Z series
Gripper mounting using screws and centering pins

- **Proven equipment details and standardized connections for universal use**
- **Very easy, direct mounting using connection kits with Easy-2-Combine interface**

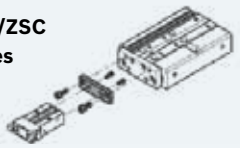
GSP/RCM series

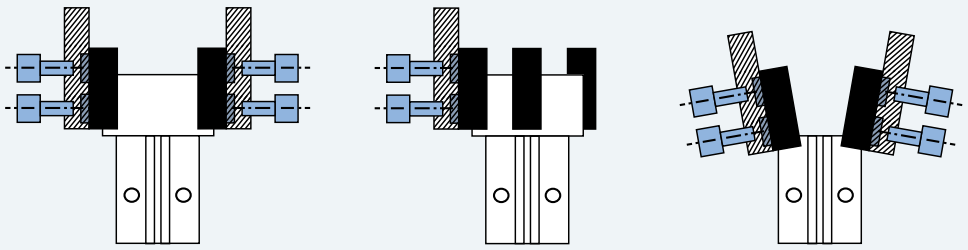
GSP/MSC series

GSP/GPC-E series



GSP/ZSC series





GSP-P series **GSP-Z series** **GSP-A, GSP-R series**

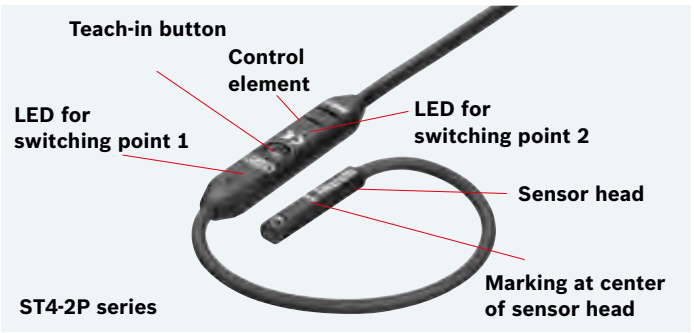
- **Fast, secure mounting of individual gripper fingers with two screws and centering rings**

Compact, sensitive, and reliable – sensors from the ST4 series provide ideal position monitoring for grippers

The right sensors for every gripper solution
High-tech in the smallest of spaces. Sensors from the ST4 series are always the first choice to monitor the pneumatic piston position in grippers. In addition to the latest sensor technology for high-precision switching and excellent process reliability, they provide all conventional connection options, whether for standard plugs or open wire ends.

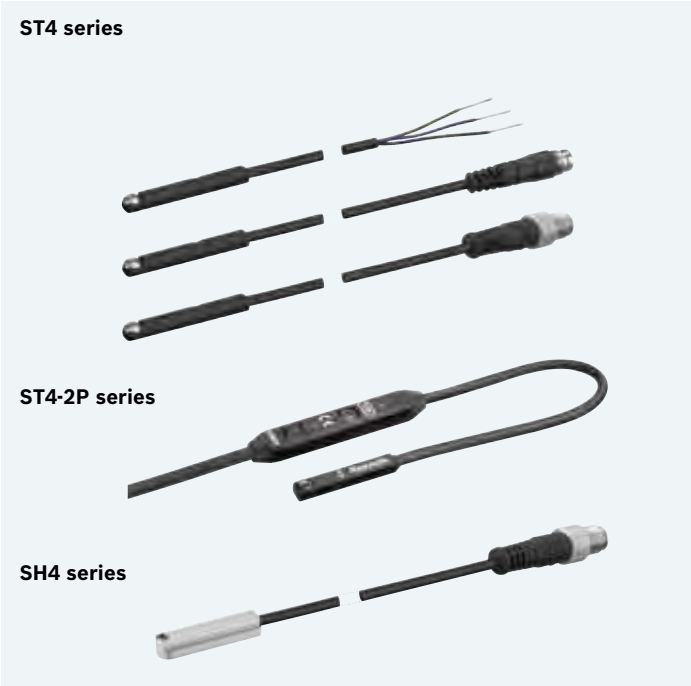
- Reed sensor or electronic magnetic field sensor
- Connection variants: open wire ends, M8, M12 plug
- The sensors can be mounted directly in the 4 mm sensor slots.

The special sensor from the SH4 series is technically comparable to the ST4; however, it has been specially optimized for the design and slots of the GSP-P 22/52 gripper series (6 mm slot).



ST4-2P series with two switching points
The ST4-2P sensor is even more convenient than the standard sensor version. It lets you store any two switching points within a 50 mm range with only a single sensor. A serial interface is provided for diagnosis and configuration.

- Easy programming via teach-in button or I/O link
- Versions with or without I/O link interface

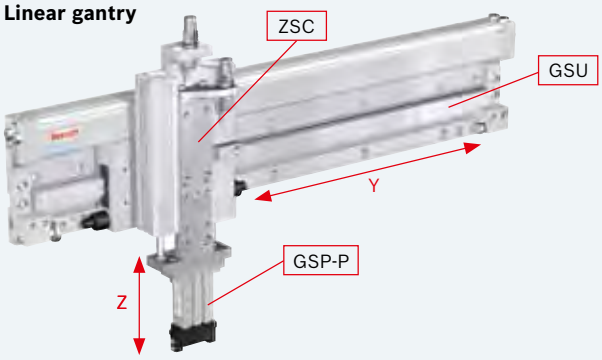


Series	ST4	ST4-2P	SH4
GSP-P	●	●	
GSP-P 72/99		●	
GSP-Z	●	●	
GSP-P 22/52			●
GSP-R	●	●	
GSP-A	●	●	

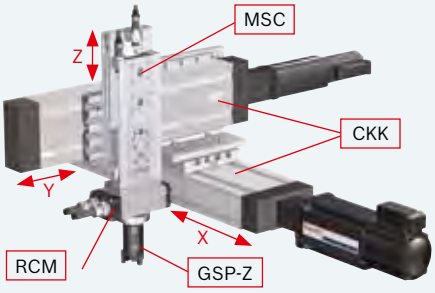
Gripper technology with Easy-2-Combine interface

Perfect integration in Cartesian systems
Simplified configuration, less engineering time, reduced assembly costs, and maximum flexibility – this is what you should expect from a handling solution. Especially for standardized applications, perfectly matched components and a proven modular design are essential. Rexroth's product portfolio contains elements that can be directly combined to suit all movement and gripping functions, and the systems expertise to match.

Linear gantry



Area gantry



Units with the Easy-2-Combine interface

Series GSP, grippers
Series RCM, rotary compact modules
Series MSC, mini slides
Series ZSC, mini slides
Series GSU, guided shuttle units
Series CKK, linear modules

GSP/RCM series

GSP/GPC-E series

GSP/MSC series

GSP/ZSC series

Online configurator for handling systems
Whether pick & place, or linear or area gantries: With our comprehensive online tool, you can configure and optimize your individual handling solution step by step. You will receive the Bill of Materials, CAD, single part number, etc.

The simple, surefire route to the best gripper layout for your application

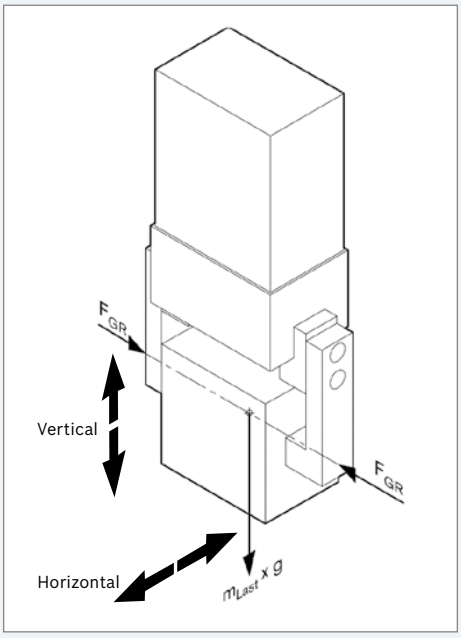
Function and efficiency: how to define the right gripper
When searching for a suitable gripper solution, a number of basic questions should be considered that determine all subsequent steps.

- Characteristics of the object to be moved
- Type and position of movement
- Gripping with a frictional or form-fitting hold
- Gripper model: parallel, radial, angular, centric

Assessing and weighting these factors requires a certain amount of practical experience in the area of handling technology. Once the basic layout has been determined, the actual configuration and calculation of all relevant forces, torques, and measurement variables can begin. This is a complex and delicate balance – a single parameter can have a major impact on the entire calculation!

Lighten your workload – take advantage of our experience and proven configuration aids
Because reliable system operation, service life, cost and energy efficiency, and, last but not least, the careful handling of workpieces or products is highly dependent on the quality of the gripper function, there should be no compromises when it comes to your configuration. Take advantage of our offer – we provide comprehensive consulting across a wide variety of systems!

Key parameters
- Minimum required gripping force
- Maximum gripper finger torque (per gripper finger)
- Maximum permissible axial force (per gripper finger)
- Friction factor of the gripper finger/workpiece combination
- Total mass of gripper element, including gripper finger and load



Sample gripping force calculation:

Vertical movements
Gripper layout (frictional fit)
Minimum required gripping force F_{Gr}

$$F_{Gr} \geq \frac{m_{load} \times (g + a) \times S}{n \times \mu} \text{ [N]}$$

Horizontal movements
Gripper layout (frictional fit)
Minimum required gripping force F_{Gr}

$$F_{Gr} \geq \frac{\sqrt{(m_{load} \times a)^2 + (m_{load} \times g)^2}}{n \times \mu} \times S \text{ [N]}$$

m_{load} = load mass [kg]
m_{Fi} = gripper finger mass [kg]
g = acceleration of gravity [9.81 m/s²]
a = max. gripper acceleration/ deceleration [m/s²]
n = number of gripper fingers
μ = friction factor
S = safety factor 1.5 to 3

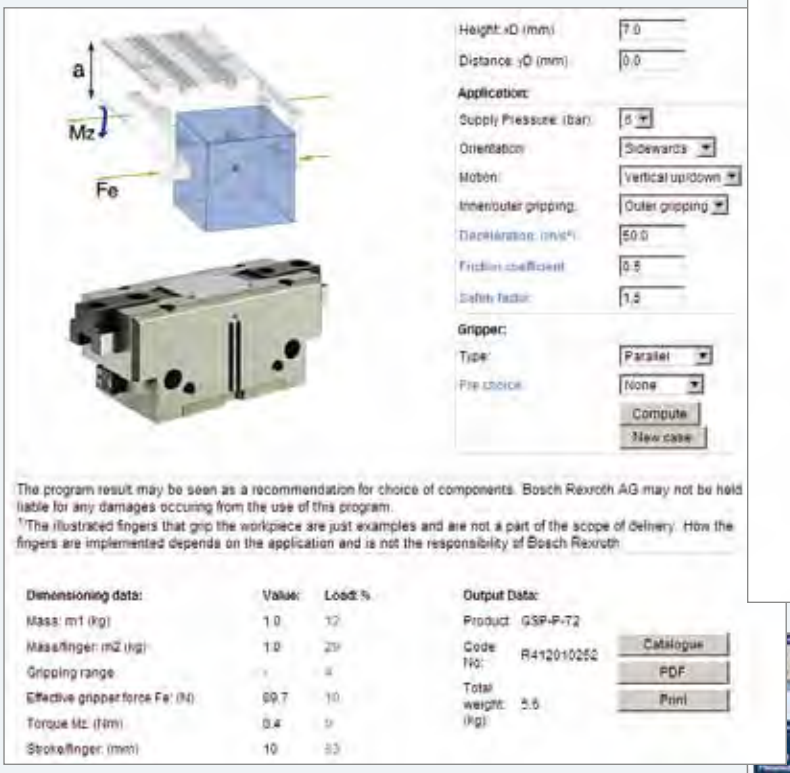
Calculation tool for grippers

The calculation tool for grippers is part of our “Product Calculation System” platform with a number of free online tools for the configuration of Rexroth components.

Excellent planning, every step of the way

After starting the gripper calculation tool, you are guided intuitively through the menu. Your individual solution is calculated using a series of questions targeting your application conditions and performance parameters. The results can be saved, and changed or updated at any time.

- Start the calculation tool
- Enter parameters
- Submit for calculation of recommended gripper
- Save results
- Direct link to product in catalog



Proven know-how and a first-class product range

Expertise, commitment, innovation
Our extensive product range provides you with a customized automation solution every time. With all the experience, commitment, and innovative potential of an global partner.

- Cross-technology solutions
- Application-specific configuration
- Innovative gripper technology

Handling made easy
Rexroth's "EasyHandling" concept has made the selection of handling systems much easier, faster, and more economical for its customers.
EasyHandling reduces engineering, assembly, and commissioning times by up to 80 percent.
Drive and control technologies, standardized interfaces, and a revolutionary new commissioning assistant are all perfectly matched.

Are you familiar with our innovative handling system "non-contact transport" (NCT)?
For numerous workpieces and materials, automated handling would not be possible without NCT. NCT grippers are not only able to do things that other gripper systems can't, they can also do them extremely well. The latest unique innovation is the NCT-PK series, specially developed for use in the food industry and highly-sensitive chemical areas.

Solar grippers

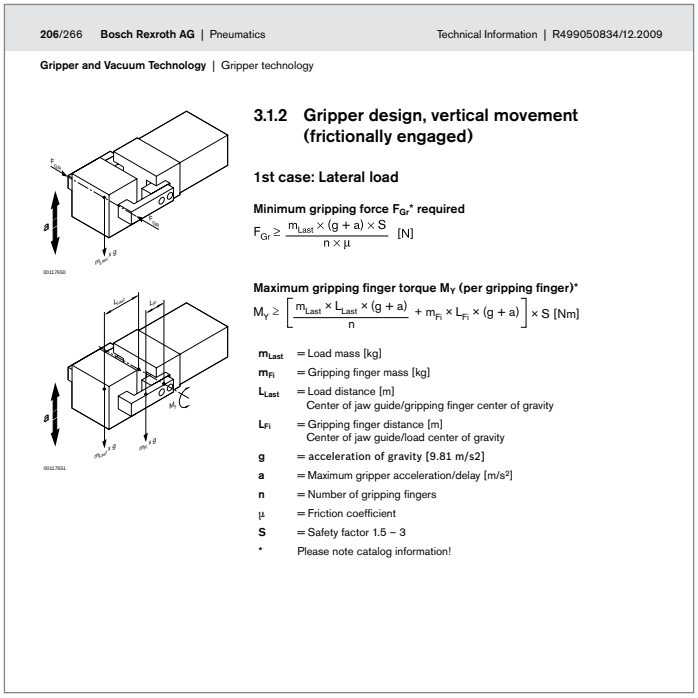
◄ **Special version for lifting and moving solar cells. Flat gripper module with 5 grippers from the NCT-AL series integrated in an aluminum plate, with lateral guides.**

Working together to find the right solution

Take advantage of our service – in person or online
We are constantly in direct dialog with our customers and are a competent contact partner for both technical and commercial topics. If you have questions about gripper technology or would like support in creating the ideal configuration for your application, in addition to our online information portfolio, you can also take advantage of personal consulting by our application and industry experts at any time.

Comprehensive, round-the-clock information
The Rexroth Internet portal supports you with all process steps – from configuration to delivery. Our online catalog provides all the product details, and the technical information contains important data on product functions and parameters.

- Key topics and product highlights in pneumatics
- Complete information in the product catalog
- Internet platform with calculation tools



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Gripper and Vacuum Technology | Gripper technology

3.1.2 Gripper design, vertical movement (frictionally engaged)

1st case: Lateral load

Minimum gripping force F_{Gr}* required

$$F_{Gr} \geq \frac{m_{Last} \times (g + a) \times S}{n \times \mu} \text{ [N]}$$

Maximum gripping finger torque M_Y (per gripping finger)*

$$M_Y \geq \left[\frac{m_{Last} \times L_{Last} \times (g + a)}{n} + m_{Fi} \times L_{Fi} \times (g + a) \right] \times S \text{ [Nm]}$$

m_{Last} = Load mass [kg]
m_{Fi} = Gripping finger mass [kg]
L_{Last} = Load distance [m]
Center of jaw guide/gripping finger center of gravity
L_{Fi} = Gripping finger distance [m]
Center of jaw guide/load center of gravity
g = acceleration of gravity [9.81 m/s2]
a = Maximum gripper acceleration/delay [m/s²]
n = Number of gripping fingers
μ = Friction coefficient
S = Safety factor 1.5 – 3
* Please note catalog information!

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