

APAS ASSISTANT

CONTACT-FREE HUMAN-ROBOT
COLLABORATION



BOSCH

Invented for life



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01

Industry 4.0 Welcome to the smart factory

Industry 4.0 combines the digital and the real world at a previously unknown level. It brings people and digital-controlled machines together with information technology and the Internet. Objects are always identifiable and communicate independently. Information is conveyed vertically from the single component to the company IT and vice versa, as well as horizontally between the machines and systems involved in production. Throughout the entire value-added chain, production and logistics processes are networked via cloud technologies in order to be able to respond promptly and flexibly to changing customer requirements in a constantly changing market environment. The reasons for these developments are continuously changing markets. They have become faster, product lifecycles have become shorter. Customers demand individualized products with a larger variety, while competition is increasing. In parallel, the demographic change will lead to a lack of workers and specialists, and impose completely new requirements on working

conditions. What's more, time pressure is increasing due to automated and extremely fast production processes. This challenges the existing value chain and has an enormous impact on our future (working) lives and on the way we produce and distribute products. On the other hand, industry 4.0 opens up entirely new possibilities for higher productivity, flexibility and quality.

Industry 4.0 at Bosch **Leading user and leading provider**

Bosch is in a unique position to drive industry 4.0 with a double strategy. As a leading user, Bosch is collecting valuable practical experience in the transformation of its own plants to industry 4.0. These experiences contribute directly to the development and implementation of new products, systems, software and solutions for the Smart Factory. This makes Bosch a leading provider of industry 4.0.





02

Human-robot collaboration Humans and machines hand in hand

Robots have improved the working world in the past years in many ways. Above and beyond the protective fencing, they usually take over tasks which are dangerous or non-ergonomic for us humans, or if we cannot keep up with speed and precision, respectively. However, humans and robots can truly form an unbeatable team, as is shown by human-robot collaboration within industry 4.0. Robots leave their safety enclosures and support their human colleagues in their direct working environment.

The idea behind human-robot collaboration is to unite the skills of humans and machines. Human-robot collaboration combines the strengths of robots with those of humans. Together, they can achieve much more than they could by themselves. While the robot is especially precise and enduring, humans have problem solving competencies, which machines cannot offer, despite their access to large amounts of data. Knowledge and experience

enable humans to assess even unforeseeable and highly complex situations and to find creative solutions. With their cognitive capabilities, humans remain at the heart of industry 4.0, and are still indispensable as decision-makers, drivers and strategists.

Collaborative robots, so-called cobots, support humans without replacing them. Instead, they complement the unique human skills and assist them, especially with monotonous, simple or ergonomically challenging tasks. This enables especially older, experienced workers to take part in working life for longer. Moreover, robots help to optimize quality, since they are able to work constantly and precisely even while performing monotonous tasks. The intelligent interplay of both partners opens up new forms of collaboration, and leads to an increase in efficiency, as well as to a long-term optimization of the entire productivity.

03

Contact-free human-robot collaboration Safe identification at performance level d

Collaborative robots or cobots work hand in hand with their human colleagues. Safe identification and collision prevention come first in human-robot collaboration. As opposed to most other robots on the market, our robot solutions stop automatically and without contact if an employee gets too close. This is due to our unique capacitive sensor skin, which surrounds the robot arm and monitors the close range around the sensor skin for the presence and absence of people.

Equipped with more than 120 sensors, the skin enables the robot to stop automatically and without contact at a safe speed of 0.5 m/s with a secure switching distance of typical 50 mm. Once the employee has left the immediate vicinity, the robot independently resumes its work exactly where it stopped before. All our systems are also certified by the German employers' liability insurance association for the direct and safe human-robot collaboration.

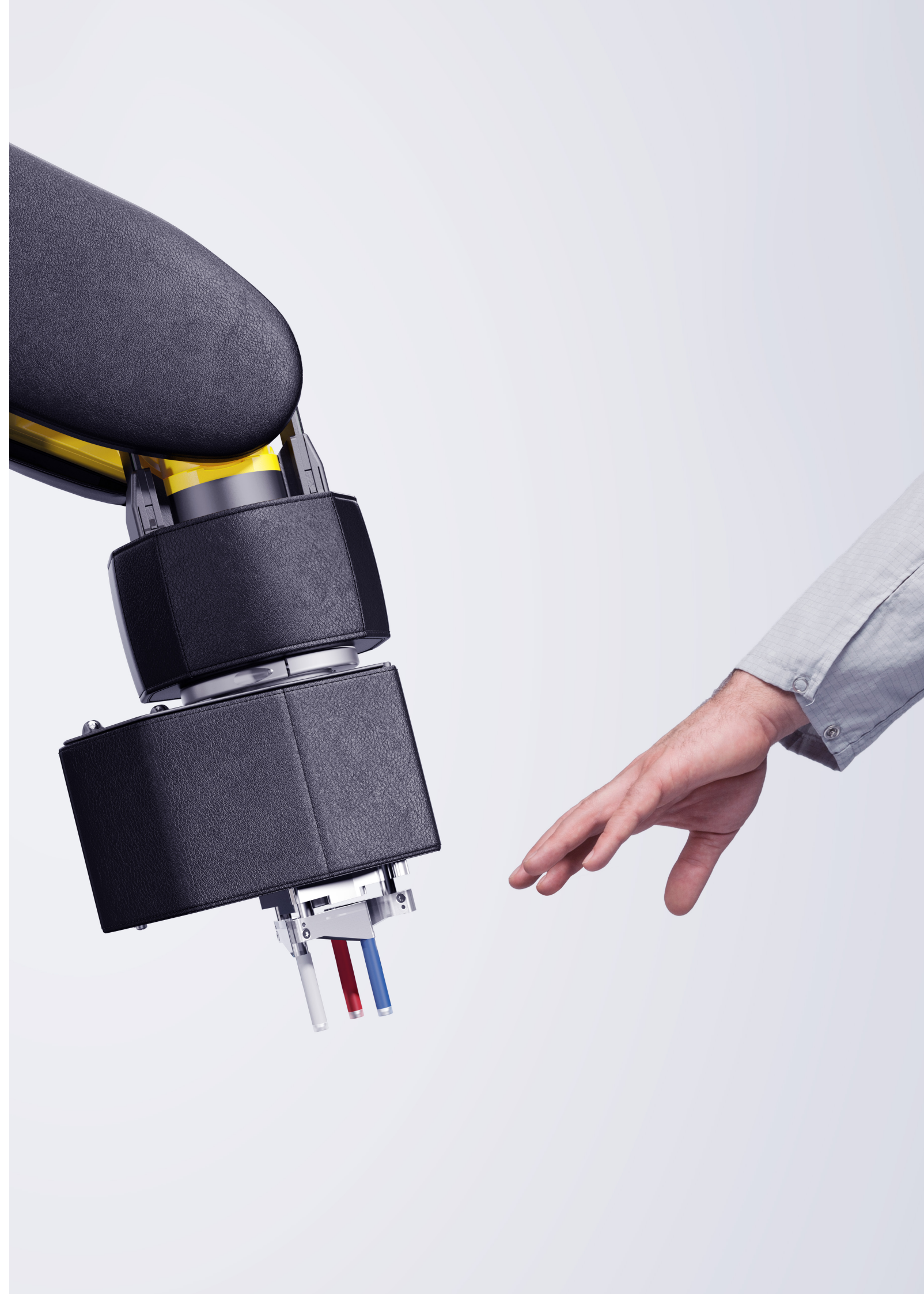
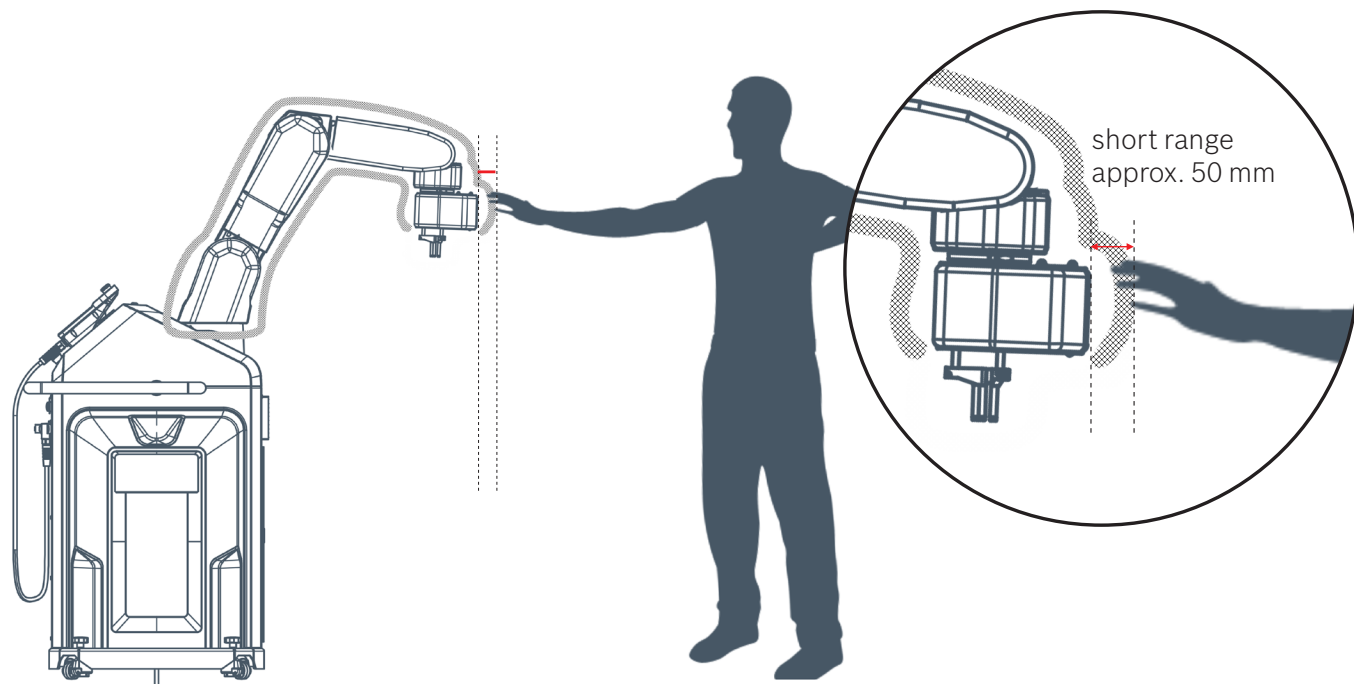


Fig. 1:
As long as the human being is outside the defined long range, the robot operates at an 4,6-increased speed of 2,3 m/s.

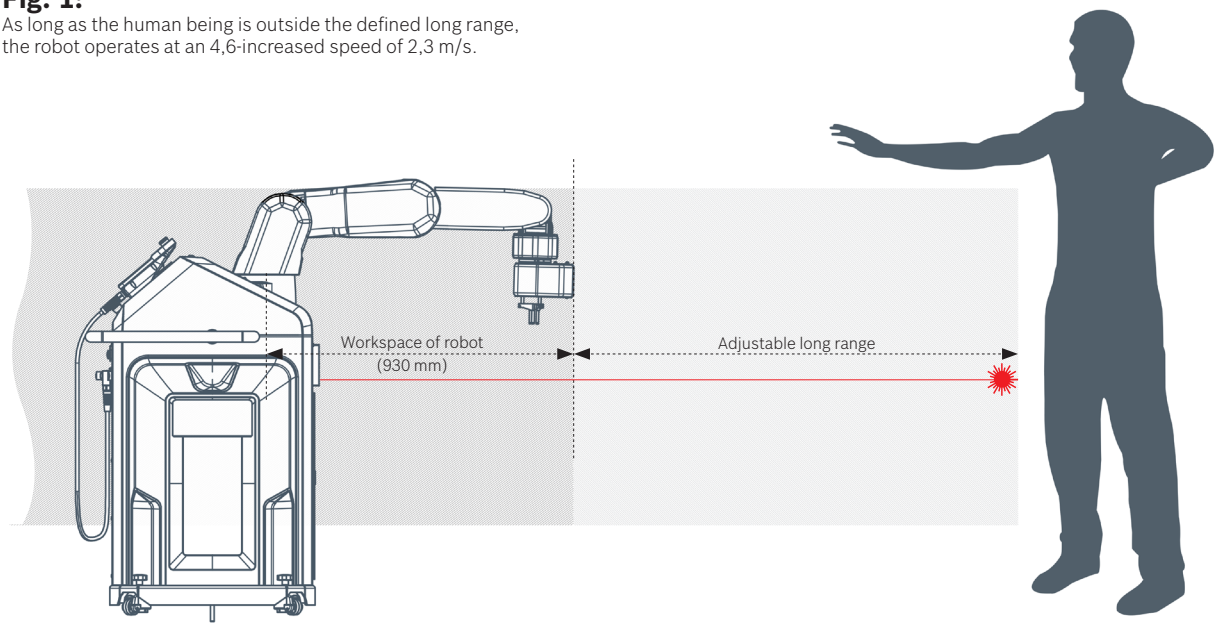
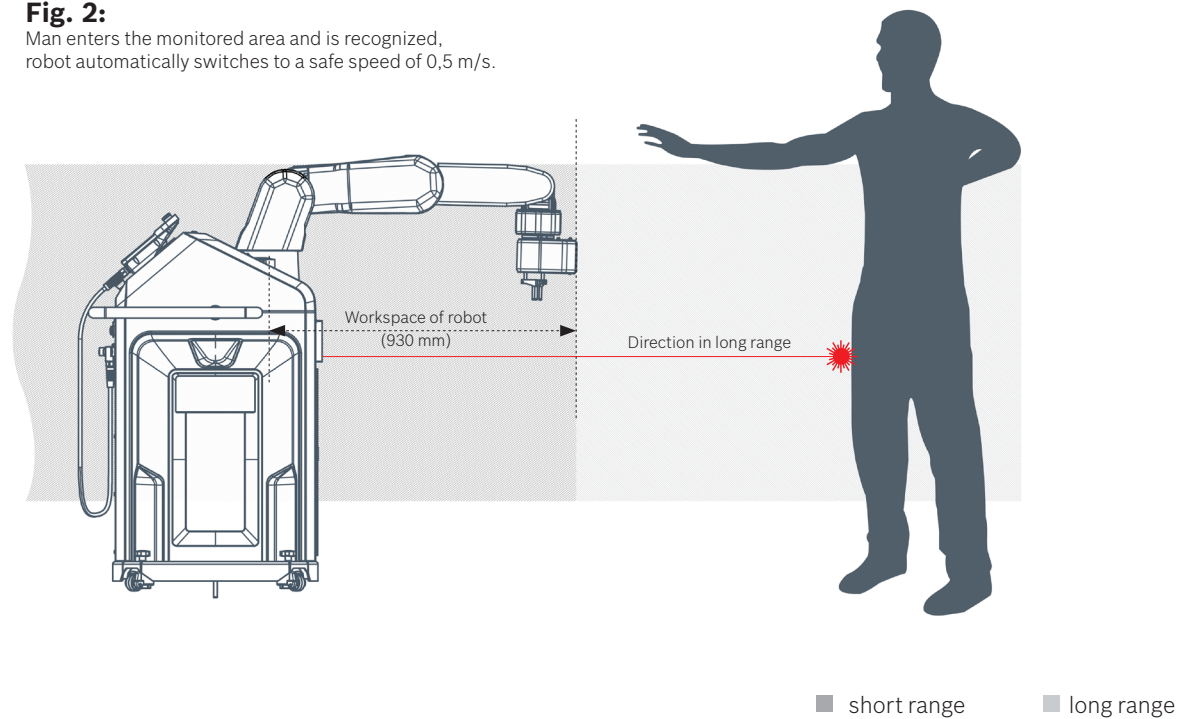


Fig. 2:
Man enters the monitored area and is recognized, robot automatically switches to a safe speed of 0,5 m/s.



04

Automatic speed adjustment

Via the APAS assistant interface for automatic speed adjustment, the so-called far range of the robot can be monitored in addition to the close range. The interface automatically regulates the speed and adapts it flexibly to the environment. As long as no human is in the work area of the robot, the robot operates at a speed of 2.3 m/s. If a human misses the distance, the APAS assistant automatically switches to a safe speed of 0.5 m/s. If the robot arm is less than 50 mm, the sensor arm monitors the sensor and stops the system. In concrete terms, this means higher productivity without reducing work safety. Various means are available for remote area monitoring, e.g. laser scanners, foot mats, light barriers, etc. We would be glad to advise you on the selection.

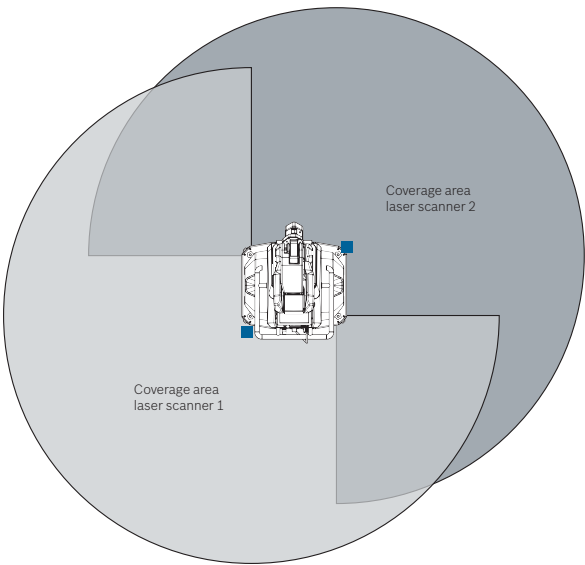


fig.:
Use of two laser scanners on an APAS assistant mobile; possible cover 360° (view from above)



05

APAS ASSISTANT MOBILE

The APAS assistant mobile is a collaborating mobile robot for flexible use in the Smart Factory. It can be used independent of location and can adapt to different tasks. The intelligent robot system is primarily intended for end users, who require a fast and budget-priced realization of new operations, as well as a highly robust, easy-to-handle and intuitively controllable system without programming knowledge.

Mobility

The APAS assistant mobile can be employed anywhere you might need it within your production facility. Thanks to its quick-fixation casters the assistant is independent of the location. A permanent alignment with the workstation is not necessary. The system's slim design allows it to be positioned at existing production lines or machines, even if very little room is available.

Flexibility

Equipped with an integrated 3D image processing system and a standardized three finger gripper, the APAS assistant mobile is a flexible complete solution. While the image processing system allows the robot to analyze its environment independently and to identify parts, the sensitive three finger gripper enables the APAS assistant to grasp and hold components and products reliably. Hence it can be easily and cost-efficiently adapted to new tasks and can take over a large variety of production jobs.

Safety

Like all our robotic systems, the APAS assistant mobile is also equipped with a comprehensive safety concept. Before a collision occurs, the APAS assistant mobile stops – without any contact. Once the employee has left the immediate vicinity, the robot independently resumes its work exactly where it stopped before.

Configuration

So-called work plans make the robot's configuration an intuitive task. The APAS assistant mobile can be trained for new tasks via step-by-step instructions. Robot, camera and gripper are applied from the same software, hence no programming knowledge is necessary. Work plans can be saved and retrieved at any time, thus leading to fast availability and cost savings, even when conditions change.

06

APAS ASSISTANT INLINE

The APAS assistant inline is a kinematic robot without safety fence designed for human-robot collaboration in the Smart Factory. As automation component, it is suited for plant installation or expansion. It is thus primarily designed for system integrators and mechanical engineers, who wish to extend their scope of solutions through collaborative robotics without having to forego the familiar programming environment.

Safety

Like all our robotic systems, the APAS assistant inline is also equipped with a comprehensive safety concept. Before a collision occurs, the APAS assistant inline stops – without any contact. Once the employee has left the immediate vicinity, the robot independently resumes its work exactly where it stopped before.

Programming

Equipped with a Fanuc LR Mate 200 iD / 7L, the standard version of the APAS assistant inline is programmed using the classic Fanuc control. In doing so, existing know-how can be used, which accelerates the entry into human-robot collaboration and simplifies the transition to the system.

inline plus

In our inline plus-version, the robot is delivered with the Bosch Control plus platform. This is a seamless control system with a comprehensive function library as well as numerous apps and software services that use the latest technologies. All processes can be bundled in a modern, object-oriented development environment and easily implemented in a structured manner.



07

Usage & application

Agile island production

Island production is used to bundle and simplify production processes and enables agile engineering with early intermediate results. Combined with other mobile complete solutions, such as the APAS inspector, agile production islands can be established, which work autonomously and make it possible to automate different components and products at different locations, for instance in small-batch production, process assurance of pilot series or quality control.

- Ad-hoc automation
- Small-batch production
- Sample inspection
- Prototype production
- Process validation of pilot series
- Quality control



Subsequent automation

As collaborative solutions, our systems do not need much space. Hence they are ideally suited to complement or expand existing lines in the course of subsequent automation. Transitions between different production steps can be accelerated, processes optimized and production times reduced. Since expensive safety enclosures are no longer needed, additional costs can be saved.

Our systems are mainly used for classic pick-and-place tasks within automated, robot-based parts handling. All kinds of workpieces are picked up by the robot's gripper and are placed as exactly as possible at a pre-defined place. Tasks such as loading or unloading of machines, sorting of workpieces or preparation of components – for instance in manual assembly – can be completed by the robot and make sure that transitions between different production steps are speeded up, processes are optimized and production times are reduced. Employees, in turn, are

relieved from monotonous jobs and can assume value-added tasks.

The repetitive accuracy of the APAS assistant is ± 0.03 mm, whereby force and position control of the gripper fingers allow both gentle and safe gripping. In the event of collision, the gripper fingers automatically retract, helping to avoid pinching and jamming. The APAS assistant can also be equipped with individual, proprietary grippers while adhering to all relevant safety standards.

- Sorting
- Palletizing and depalletizing
- Parts provision, preparation and feeding
- Handling of various tools for different tasks

08

Service & application



Feasibility study & implementation

The planning of your flexible factory begins with you on site. Together, we take a look at your current concept and discuss the possibilities for greater efficiency and productivity. During the planning process, you are involved in all steps and thus always keep an overview. After the realization, you will receive the certification and acceptance of your station - and this of course by adhering to all standards.

Training

Through our worldwide presence at different locations in Europe, Asia and America, we always guarantee proximity to our customers. We can organize special training courses, workshops and coaching sessions, which we develop and assemble with you according to your requirements. At our Training Center or at your local office.

CE certification

Our robotic systems are delivered as incomplete machines with installation declaration. Only together with the application do they become a complete machine. According to EU Machinery Directive, a machine may only be operated with a CE symbol. The operator is responsible for correct operation. We take care of the issuing of the CE mark and support you in the safe commissioning of your applications. This also applies to applications that Bosch has not created itself.

Business models

With our flexible business models, you decide whether you want to use a device permanently or for rent.

09

Training

In our Training Center, you will experience and train in practical exercises the efficient use of our products in real situations. You will be professionally supported and supervised by experienced coaches for your daily work.

BASIC TRAINING COURSE

| | |
|--|---------------|
| Safe handling for operators, maintenance technicians and applicators | [PA-PS-AP011] |
|--|---------------|

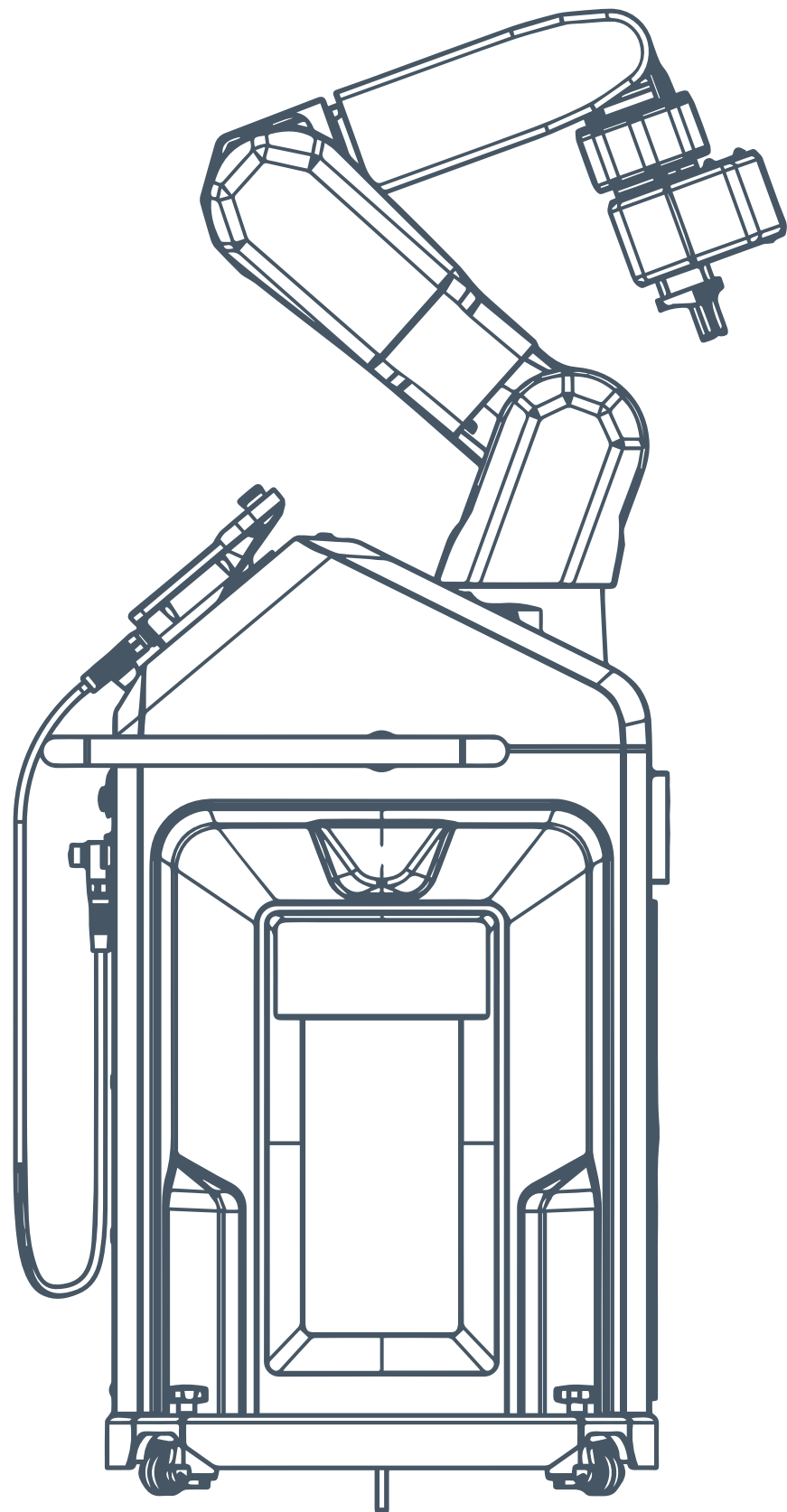
ADVANCED TRAINING COURSE

| | |
|---|---------------|
| Troubleshooting and fault removal for maintenance technicians | [PA-PS-AP012] |
|---|---------------|

| | |
|--|---------------|
| Maintenance of the sensor skin for maintenance technicians | [PA-PS-AP015] |
|--|---------------|

| | |
|--|---------------|
| Preparation of complex working plans for applicators | [PA-PS-AP018] |
|--|---------------|





Technical data assistant mobile

| GENERAL | |
|-----------------------------|---|
| Dimensions (W x H x D) | 775 mm x 1.600 mm x 730 mm |
| Height (robot outstretched) | 1.900 mm |
| Height (transport position) | 1.600 mm |
| Weight | approx. 230 kg |
| Power supply | AC 230 V |
| Interfaces | Ethernet, EtherCat, E/A non-isolated |

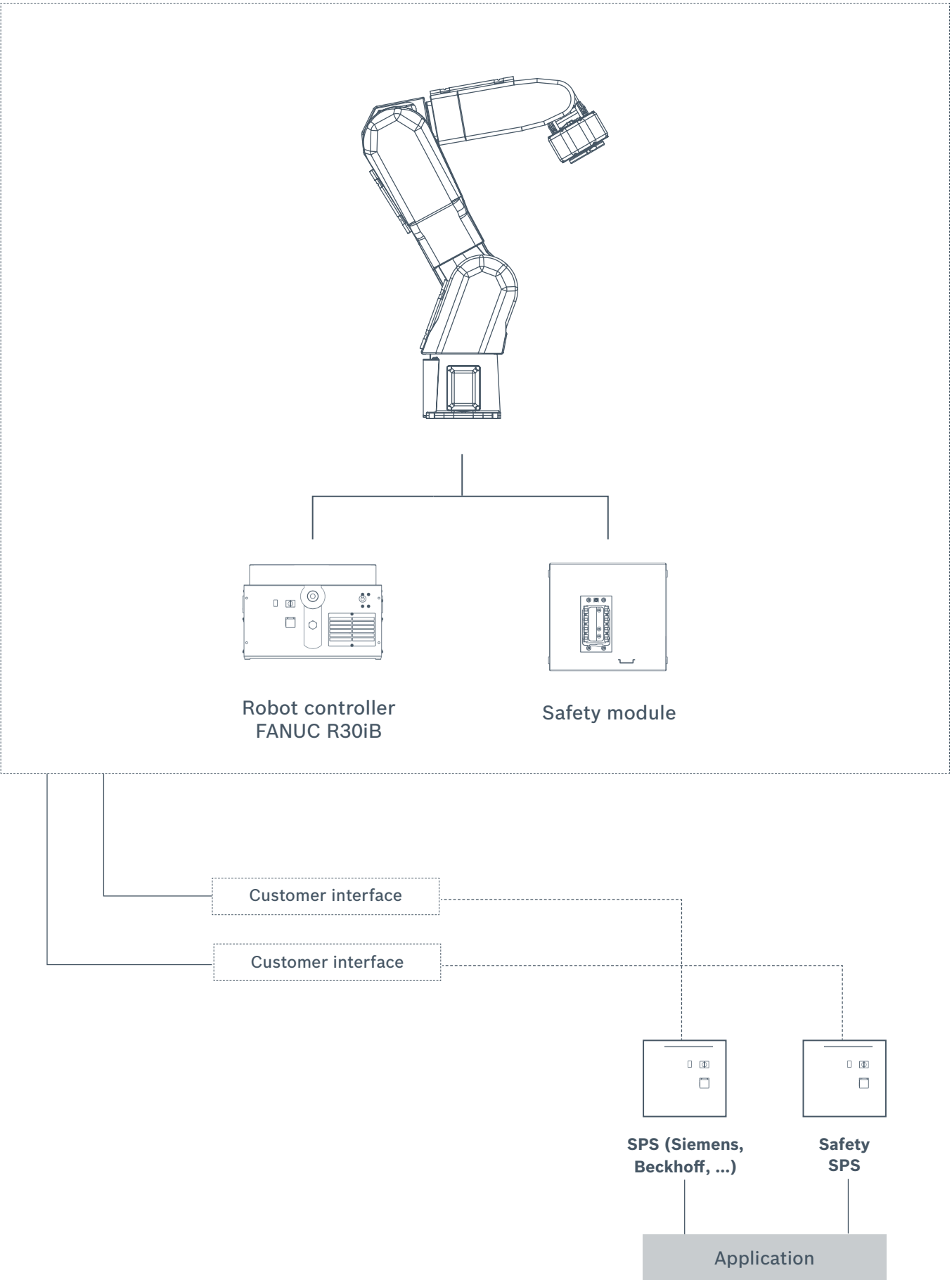
| ROBOT | |
|-----------------------------|---|
| Model | Fanuc LR Mate 200 iD/7L |
| Pick & Place cycle duration | application-specific |
| Reach | 911 mm |
| TCP speed | safe speed with sensor skin monitoring in close range 0.5m/s opt. high speed with remote range monitoring 2.3m/s |
| Repeatability | +/- 0,03 mm |
| Payload | max. 5,5 kg |
| Safety Sensor | non-contact (capacitive) |
| reliable safety distance | typical 50 mm |

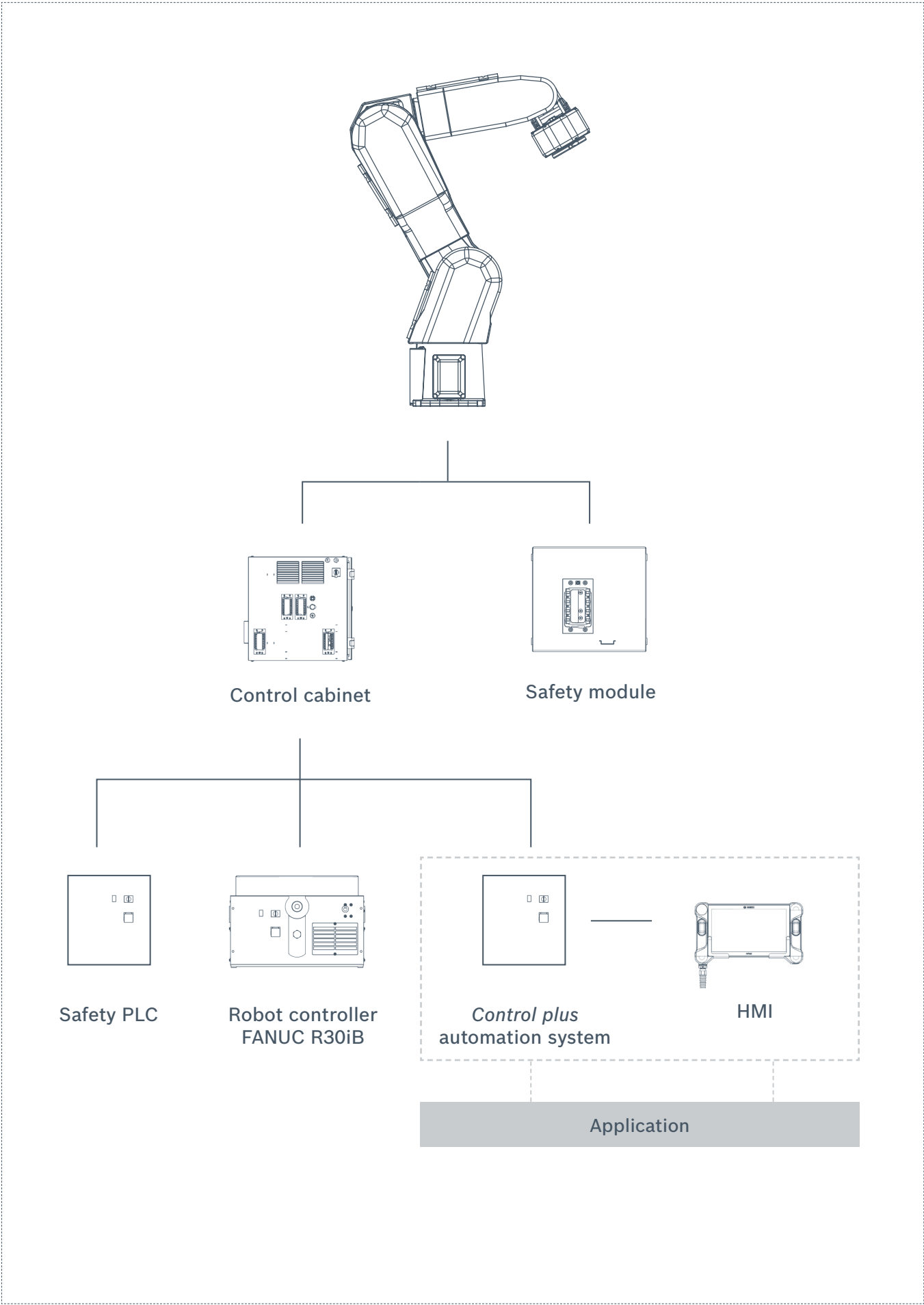
| THREE-FINGER-GRIPPER | |
|----------------------|--|
| Principle | universal three-finger gripper |
| Force control | adjustable in gripping direction 40 -120 N |
| Position control | 0 - 130 mm opening diameter |
| Payload | max. 2 kg |
| Payload | max. 2 kg |

| VISION | |
|---------------------|-------------------------------|
| Overview camera | 2D monochrome |
| Positioning camera | 3D, calibrated stereo cameras |
| Field of view | 250 mm x 250 mm |
| Integrated lighting | 1x infrared |

Technical data assistant inline

| ROBOT | |
|-----------------------------|---|
| Model | Fanuc LR Mate 200 iD/7L |
| Pick & Place cycle duration | application-specific |
| Reach | 911 mm |
| TCP speed | safe speed with sensor skin monitoring in close range 0.5m/s opt. high speed with remote range monitoring 2.3m/s |
| Weight | approx. 35 kg |
| Repeatability | +/- 0,03 mm |
| Payload | max. 5,5 kg |
| Safety sensor | non-contact (capacitive) |
| Reliable safety distance | typical 50 mm |





Technical data assistant inline plus

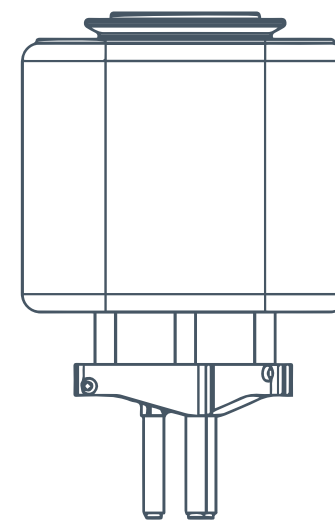
| ROBOT | |
|-----------------------------|---|
| Model | Fanuc LR Mate 200 iD/7L |
| Pick & Place cycle duration | application-specific |
| Reach | 911 mm |
| TCP speed | safe speed with sensor skin monitoring in close range 0.5m/s opt. high speed with remote range monitoring 2.3m/s |
| Weight | approx. 35kg |
| Repeatability | +/- 0,03 mm |
| Payload | max. 5,5 kg |
| Safety sensor | non-contact (capacitive) |
| Reliable safety distance | typical 50 mm |

| SWITCH CABINET | |
|---|---|
| Dimensions (W x H x D) | 550 mm x 600 mm x 600 mm |
| Weight | approx. 120 kg |
| Ambient temperature | max. 32 °C |
| Length of the connecting cable to the robot arm | approx. 3 m |
| Length of the connecting cable to the touch pad | approx. 4,5 m |
| Electric feeding | 1 / N / PE AC 230V 50 Hz |
| Control voltage | DC 24 V |
| Full load / short-circuit current | 7,4A / 10kA |
| Min. supply line | 3 x 2,5mm ² / 1 x 10mm ² PE |
| Max. fuse | 16A gG |
| Protection class | IP54 |
| Recommended wire size | 16 mm ² |

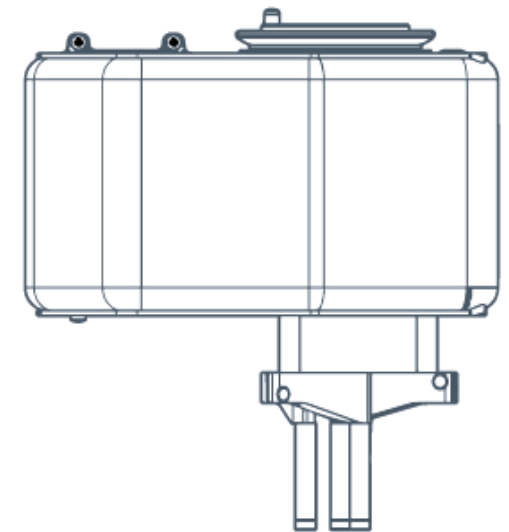
End effectors

Extend the functions of the robots with our additional offer. With our end effectors, we offer you individual solutions for your tasks. They enable the high-precision gripping of different parts and also allow the handling of different tools. Customer-specific grippers can also be easily adapted.

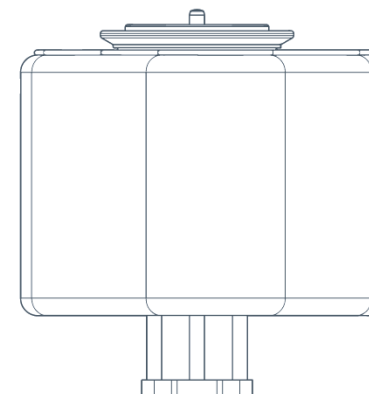
Three-finger-gripper



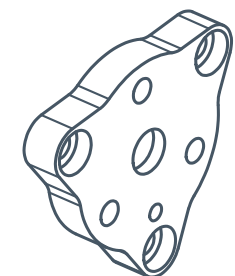
Three-finger-gripper with integrated camera system

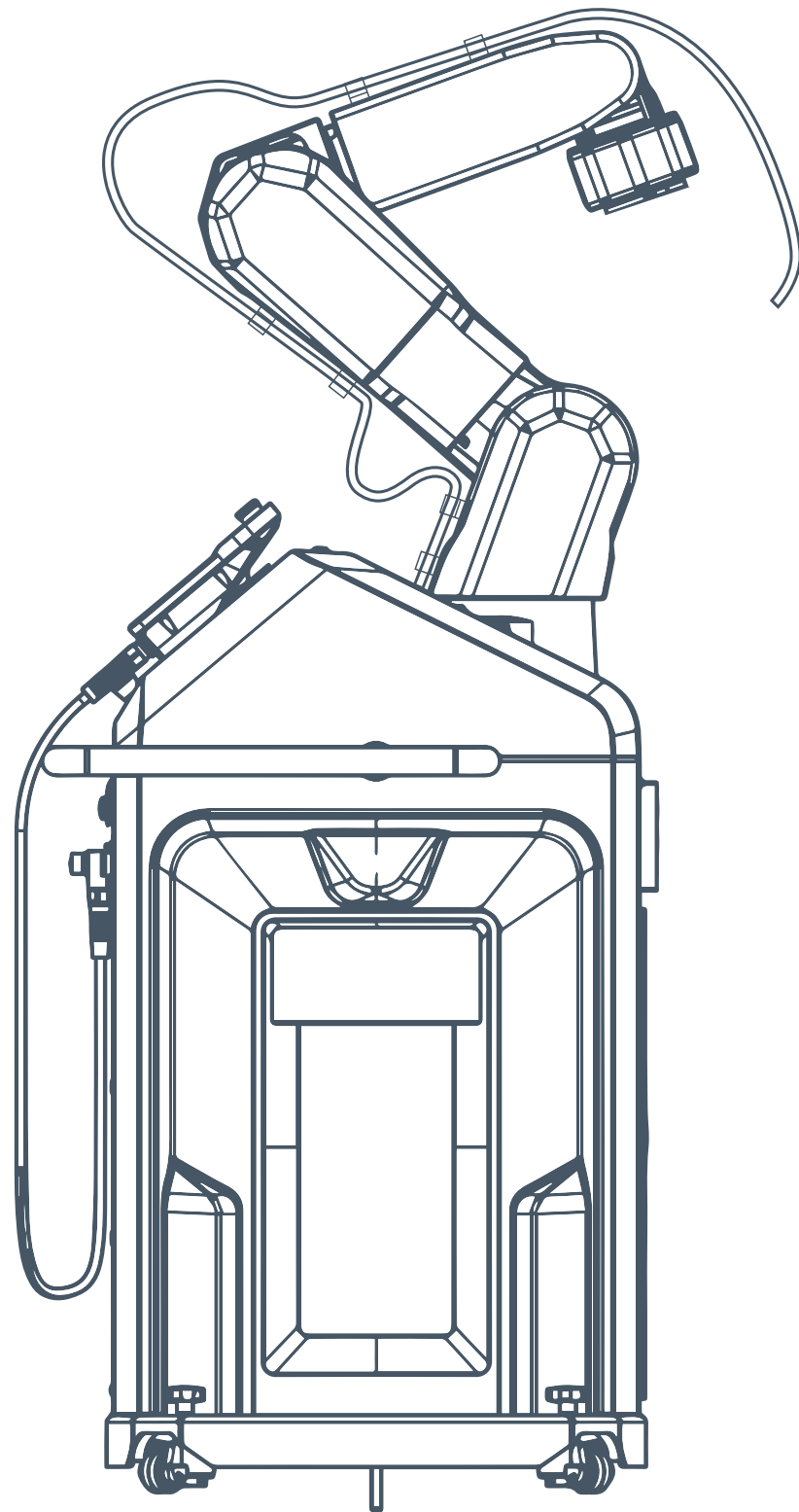


Safety element for attachment of own grippers



Safety element for attachment of own grippers



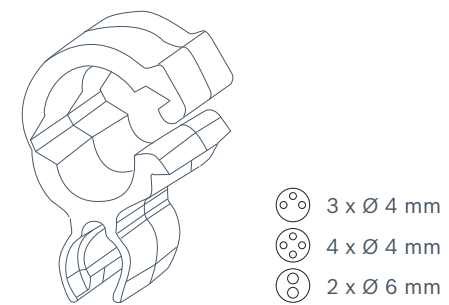


Pneumatic Kit

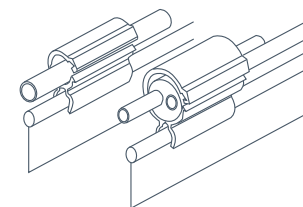
With the components of the pneumatic kit, the pneumatic lines are detachably attached to the piping of the sensor skin using clips.

| CONNECTION OPTIONS | |
|--------------------------------|--------|
| Max. 4 lines (with hose spout) | Ø 4 mm |
| Max. 2 lines (with hose spout) | Ø 6 mm |
| max. 1 line | Ø 8 mm |

Available mounting clips



Cable routing via small clip or via hose nozzle in large clip



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This document is a schematic representation and not an operating manual. Occasional differences of the images to the operating manual are possible. Please refer to the operating manual with regard to the proper use of the system.