

motion

02.2019

THE MAGAZINE WITH DRIVE

ROBOTICS

THE NEXT EVOLUTION
IN THE OPERATING ROOM



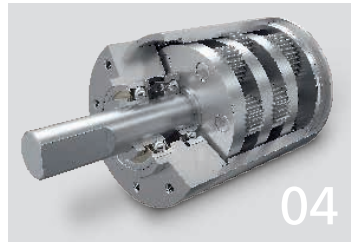
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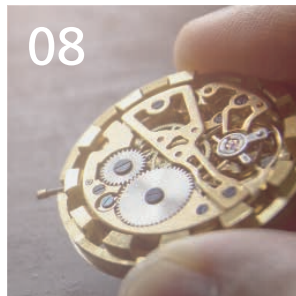
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Dear readers,

Christmas will soon be upon us and sweet treats are appearing in the shops. In order for delicacies to melt in your mouth, a great deal needs to be observed during production. The perfect viscosity is an important quality feature here and is decisive for the workability in the production process. To measure the viscosity, Brabender has realised a new rotational viscometer with the ViscoQuick, which uses a brushless DC-servomotor from FAULHABER.

I am proud that FAULHABER was awarded first place in the ranking of Germany's most innovative medium-sized enterprises. For this purpose, Munich Strategy examined 3,500 companies on behalf of WirtschaftsWoche, a German weekly business news magazine. "Not only is FAULHABER able to manage an incredibly complex product portfolio in order to produce according to customer requirements, the company also sets new standards in the area of innovation culture", says Dr. Sebastian Theopold, founder of Munich Strategy.

In July of this year, MicroMo Electronics Inc. (Clearwater, Florida) was integrated as FAULHABER MICROMO LLC, and thereby became part of the FAULHABER Drive Systems division within the FAULHABER GROUP. We are happy to have successfully completed this integration. FAULHABER MICROMO remains under family ownership as wholly-owned subsidiary of Dr. Fritz Faulhaber GmbH & Co. KG. Through the integration, our position on the North American market as a leading provider of high-precision miniature drive systems will be further strengthened.

Learn more about these and other exciting topics in this issue of FAULHABER motion – the magazine with drive.

I wish you a stimulating read!

Sincerely

Gert Frech-Walter
FAULHABER GROUP Management



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EXPAND YOUR POSSIBILITIES

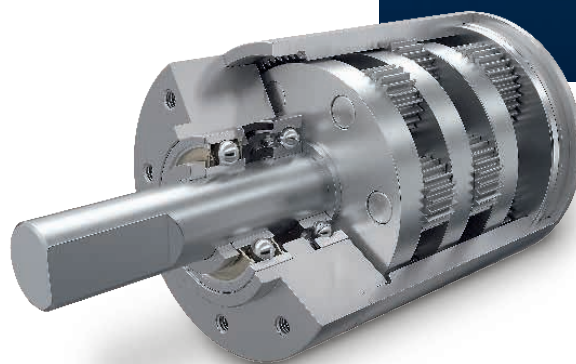
FAULHABER GPT PRECISION GEARHEADS

With the new FAULHABER GPT series of gearheads, you move up a gear where others downshift. The pure metal gearheads achieve performance values that are comparable to those of significantly more expensive technologies available on the market, such as those that use ceramic components. The gearheads are available with diameters of 22, 32 and 42 millimetres. They achieve top values for torque as well as for speed. Compared to the predecessor models, the input speed was more than doubled to over 10,000 rpm. During intermittent operation, it can reach up to 20,000 rpm.

The gearheads of the FAULHABER GPT series are designed to be extremely robust and tolerate both continuous as well as very abrupt and sudden load changes. They can be equipped with up to four reduction stages. Each stage was individually optimised for high performance with respect to torque and speed. One special feature of the product family is the high number of available gear ratios and their very uniform distribution. As a result, the motor power can be utilised optimally. At the same time, they are significantly shorter than other models with the same diameter. Thanks to their minimal play, they are especially well suited for tasks with precise positioning.



faulhaber.com/GPT/en



PRECISION GEARHEADS
FAULHABER GPT SERIES

SENSOR-FREE VERSION MORE THAN 1,500 AUTOCLAVE CYCLES POSSIBLE



STERILISABLE BRUSHLESS DC-SERVOMOTORS 2057 ... BA

FAULHABER developed the new sterilisable 2057...BA family of motors especially for medical applications. The motors are fitted in a moisture-resistant, stainless steel housing. During the development process, they were thoroughly tested for resistance to the loads experienced during autoclaving. Based on these tests, it is ensured that the standard motor can withstand undamaged at least 1,000 cycles in the autoclave. For the sensor-free variant, this value is 1,500 cycles. The drives are optimised for high speeds of up to 65,000 rpm. Furthermore – like all motors from FAULHABER – they are characterised by high power values in relation to their volume. They are therefore very well suited for tight installation situations. Their low weight makes them predestined for use in the handpieces with which doctors and dentists perform delicate tasks, often over several hours.



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DOUBLE PREMIERE TWO NEW ENCODERS PRESENTED

The BXT family of motors was expanded with the diameter-compliant IEF3-4096 magnetic encoder. The combination of the BXT motors with the IEF3-4096 encoder is the ideal solution if it is necessary to precisely position in a constrained space and high torques are also required. In this flat design, the IEF3-4096 offers three channels with index function and a high resolution of up to 4,096 lines per revolution. Furthermore, a variant with line driver is available with the IEF3-4096 L.

To eliminate interferences during signal transmission, the new magnetic, single-turn AES-4096 L absolute encoder was equipped with a line driver. Thus, the motor/encoder unit can be positioned up to five metres away from the controller. The encoder can be combined with brushless DC-motors of the B, BX4 and BP4 series. It transfers signals using the BiSS-C protocol. The BiSS protocol is designed for industrial applications in which high transmission speed, flexibility and minimal implementation effort are required.



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MOTOR WITH INTEGRATED ENCODER 2232 ... BX4 AES-4096 L SERIES



MOTOR WITH INTEGRATED ENCODER 3216 ... BXT IEF3-4096 SERIES

MICROMO IS NOW FAULHABER MICROMO

The FAULHABER GROUP is restructuring its North American Operations Center to accelerate future growth.



In July 2019, MicroMo Electronics Inc. (MICROMO) was officially integrated as FAULHABER MICROMO LLC, and thus becomes part of the FAULHABER Drive Systems division of the FAULHABER GROUP. The integration represents the realization of the long-term vision of the late owner of the company, Dr. Fritz Faulhaber Jr. FAULHABER MICROMO's position on the North American market as a leading provider of high-precision miniature drive systems should thereby be further strengthened and expanded. Dr. Faulhaber's objective of a family-owned single corporate unit was carried through by his widow Ping Faulhaber. The previous managing director of MICROMO, Ping Faulhaber, explains: "This integration ensures that FAULHABER MICROMO can grow over the course of generations and create added value for our high-tech customers under a single name and with a shared vision as a company, managed by the Faulhaber family." FAULHABER MICROMO remains under family ownership, including Ping Faulhaber, as wholly-owned subsidiary of Dr. Fritz Faulhaber GmbH & Co. KG with headquarters in Schönaich, near Stuttgart, Germany.



Karl Faulhaber, CEO of
FAULHABER MICROMO LLC

**"THE NAME FAULHABER
MICROMO IS A GOOD
CHOICE FOR THE FAMILY
COMPANY,"**

because it honours important elements of both of the founders' legacies" says the new CEO of FAULHABER MICROMO LLC, Karl Faulhaber. He is the grandson of the founders of MicroMo Electronics Inc. and Dr. Fritz Faulhaber GmbH & Co. KG.

FAULHABER MICROMO LLC
located in FL/USA
© FAULHABER



FAULHABER MICROMO plans to further intensify service and product support on site for the North American market. As the global market leader for high-precision drive systems, FAULHABER's extensive competencies in the areas of engineering, design and project management should contribute greatly in achieving this.

This organizational transformation will be accompanied by a transition from the existing MICROMO company brand to the FAULHABER brand which bears the name of the founding family and has become known around the world as a recognised symbol of high quality and innovation in the area of drive technology.



FAULHABER MICROMO TEAM



[faulhaber.com/news](https://www.faulhaber.com/news)

FILIGREE POWERHOUSE

High-quality mechanical watches are pieces of fine jewellery with a complex inner life. To produce these marvels of craftsmanship, countless individual steps must work together in a refined way. Today, watches are often put together at assembly stations, which support the highly qualified watchmakers with semi-automated processes. During transport of the valuable watch movements, motors from FAULHABER ensure delicate and smooth handling sequences.



Mechanical watches are actually an anachronism, as they are no longer really needed for measuring time. Nevertheless, demand remains high. Many purchasers are looking not only for a prestigious piece of arm jewellery but also feel a deep appreciation for the extraordinary refinement of the precision mechanics of their timepieces. They are based on the highly developed craftsmanship that has been passed on over the centuries from generation to generation, primarily in Switzerland. Most of the industry's big-name manufacturers are located there.

Cluster for cutting-edge technology

Today, these manufacturers produce their products in quantities that a pure craft workshop – a watchmaker builds the entire watch from A to Z – could not handle. Although the most important work steps are still performed largely by hand, the work is shared and broken down into various processes. The skilled workers are supported in many of the steps by machines, which automate the process to a certain degree.

One such machine is the assembly station (French: poste d'assemblage) from Precitrame Machines. The Swiss company is based at approximately 900 m above sea level in Tramelan, a small town in the Bernese Jura, in the immediate vicinity of some of the most renowned watch manufacturers in the world. The



region is also a typical cluster of hidden champions for precision mechanics, mechatronics and machine construction. Dozens of companies that are associated with watchmaking, arose from it or, among other things, serve as suppliers to the industry, are all based there in a small area. They are characterised by the same attributes as the well-known watch names: products of the highest quality and technology that is among the best in the world in the respective fields.

Optical and acoustic measuring instruments are used to, e.g., measure the rate and amplitude of the regulating element or to check the completeness of the components.

World leader in technology.

Precitrame produces machines for rotary-indexing transfer and finishing for precision mechanical production of every type as well as the aforementioned assembly station for watchmaking. When the housing of this machine is closed, one sees a work surface that contains a small, round opening at the front centre. There, the watchmaker receives the movement to perform the next assembly step. Once completed, the watchmaker returns it to the same location. The workpiece is now transported onwards under the cover while the next one arrives for processing.

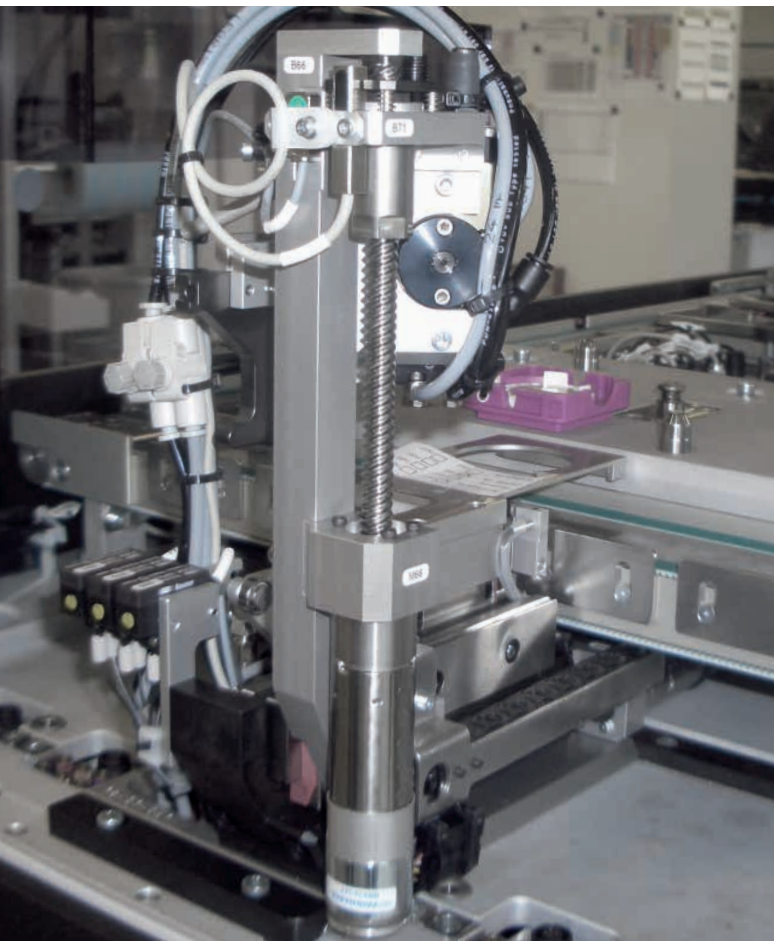
Mini-factory under the housing

Located under the cover is something that has the appearance of a miniature version of an assembly plant. Numerous conveyor belts run next to one another there. These move the workpieces back and forth, pass through a series of switches and can thereby direct them on different paths depending on what work step is currently being performed on the batch.

All movements, however, enter a loading device (French: *chargeur*) in the rear part of the station that lifts them from the conveyor belt and directs them to an automated process. This may involve, e.g., applying a microscopically fine drop of oil to a specific location. This unit is, however, primarily responsible for quality assurance. Sophisticated systems remeasure here to ensure that the assembly processes were performed with the desired precision.



Miniature version of an assembly plant
© Precitrame

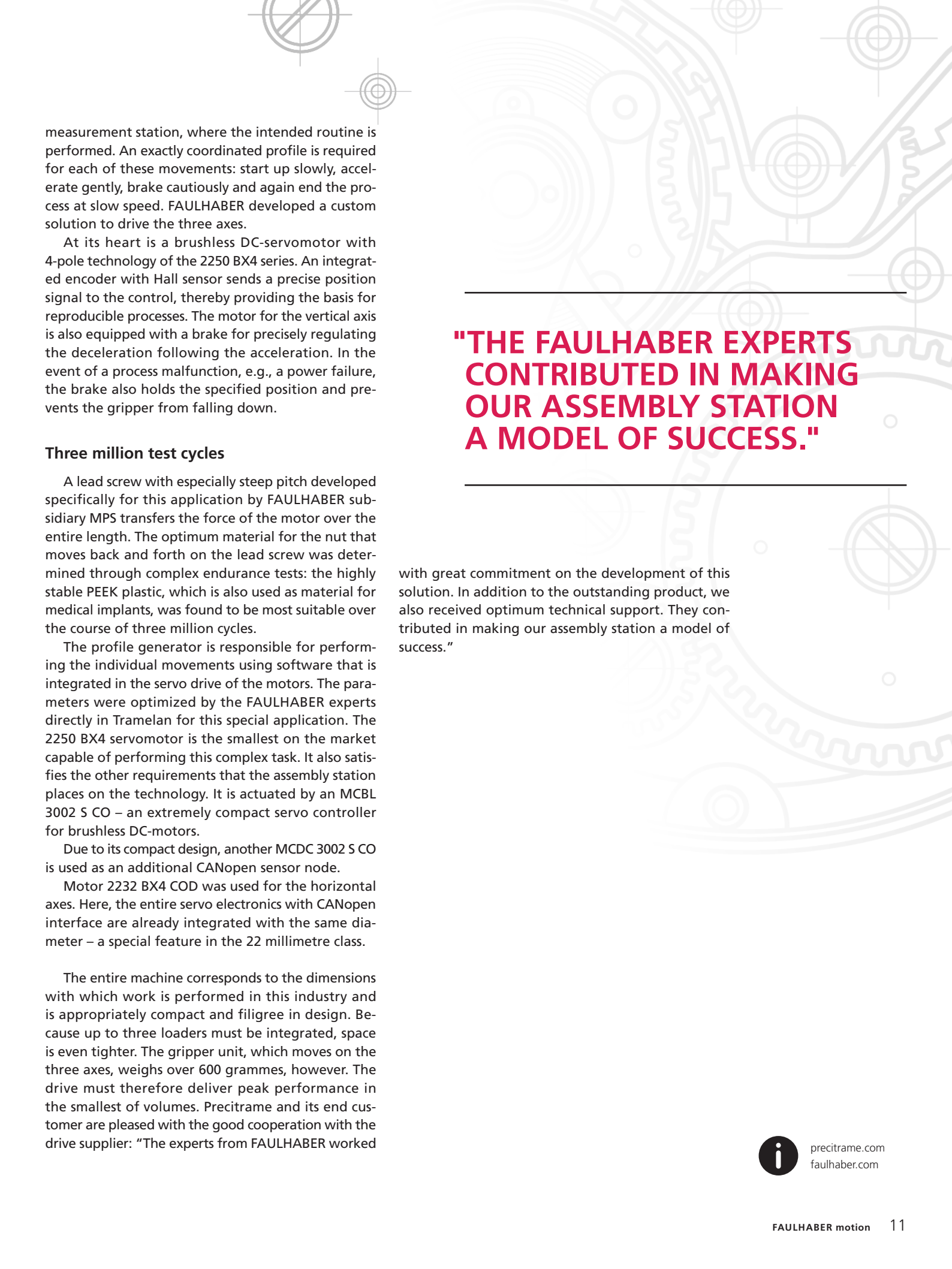


Gentle acceleration

Furthermore, three processes must be precisely synchronised: the transport pallet with the workpiece carrier is moved to the gripper on a horizontal axis. This grips the carrier and moves vertically upwards. Once there, the gripper moves horizontally to the

The Gripper hand moves on three axes. © Precitrame





measurement station, where the intended routine is performed. An exactly coordinated profile is required for each of these movements: start up slowly, accelerate gently, brake cautiously and again end the process at slow speed. FAULHABER developed a custom solution to drive the three axes.

At its heart is a brushless DC-servomotor with 4-pole technology of the 2250 BX4 series. An integrated encoder with Hall sensor sends a precise position signal to the control, thereby providing the basis for reproducible processes. The motor for the vertical axis is also equipped with a brake for precisely regulating the deceleration following the acceleration. In the event of a process malfunction, e.g., a power failure, the brake also holds the specified position and prevents the gripper from falling down.

Three million test cycles

A lead screw with especially steep pitch developed specifically for this application by FAULHABER subsidiary MPS transfers the force of the motor over the entire length. The optimum material for the nut that moves back and forth on the lead screw was determined through complex endurance tests: the highly stable PEEK plastic, which is also used as material for medical implants, was found to be most suitable over the course of three million cycles.

The profile generator is responsible for performing the individual movements using software that is integrated in the servo drive of the motors. The parameters were optimized by the FAULHABER experts directly in Tramelan for this special application. The 2250 BX4 servomotor is the smallest on the market capable of performing this complex task. It also satisfies the other requirements that the assembly station places on the technology. It is actuated by an MCBL 3002 S CO – an extremely compact servo controller for brushless DC-motors.

Due to its compact design, another MCDC 3002 S CO is used as an additional CANopen sensor node.

Motor 2232 BX4 COD was used for the horizontal axes. Here, the entire servo electronics with CANopen interface are already integrated with the same diameter – a special feature in the 22 millimetre class.

The entire machine corresponds to the dimensions with which work is performed in this industry and is appropriately compact and filigree in design. Because up to three loaders must be integrated, space is even tighter. The gripper unit, which moves on the three axes, weighs over 600 grammes, however. The drive must therefore deliver peak performance in the smallest of volumes. Precitrame and its end customer are pleased with the good cooperation with the drive supplier: "The experts from FAULHABER worked

**"THE FAULHABER EXPERTS
CONTRIBUTED IN MAKING
OUR ASSEMBLY STATION
A MODEL OF SUCCESS."**

with great commitment on the development of this solution. In addition to the outstanding product, we also received optimum technical support. They contributed in making our assembly station a model of success."



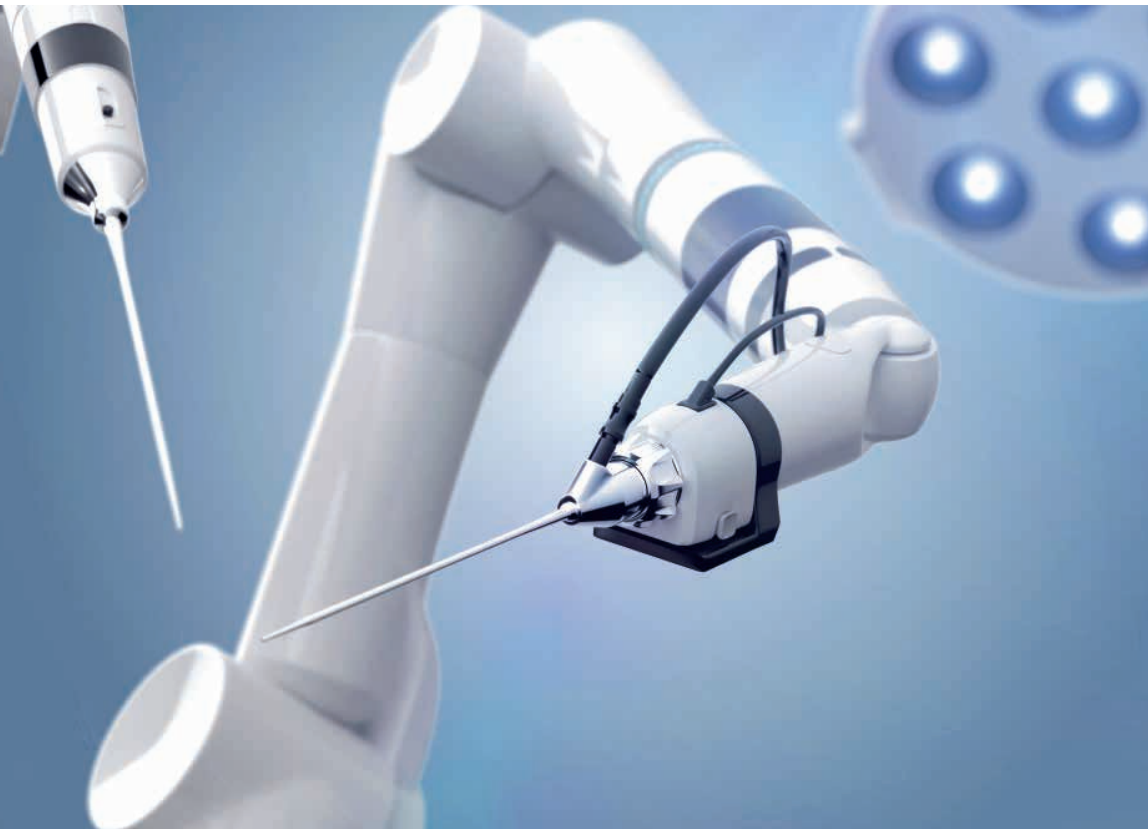
precitrame.com
faulhaber.com

ROBOTICS

THE NEXT EVOLUTION IN THE OPERATING ROOM

After taking over industry, robots are now conquering the medical sciences. The advantages are obvious: absence of fatigue, maximum precision and speed, optimum ergonomics. Experts see their use as the next evolution in the treatment of patients. Already today, robot systems are used in a number of surgical applications, such as in orthopaedics, in neurology or in cardiothoracic and ENT surgery. In addition to established manufacturers, innovative start-ups are entering the market.





Medical technology relies on FAULHABER not only in robot-supported procedures. For example, drive systems are used in implantable heart pumps, surgical hand tools, in ophthalmology, in cosmetics and in medical imaging and image processing.

An air of quiet concentration prevails in the operating room. The team prepares the patient for the operation. But the first incision is performed not but a doctor, but by a robot. The surgeon sits focused in front of his surgical console and uses the joysticks to control the robot arms that are used for the procedure performed at the operating room table. Even after a 24-hour shift, the robot cuts absolutely precisely and smoothly. The camera, which is important above all for minimally invasive operations, provides optimally prepared images absolutely free of vibrations. On the 3D monitor, the doctor can see exactly what is happening in the patient's abdomen. Instead of

the conventional 2D view, which is often very limited, he can see every detail on the 3D monitor. In addition, the slim, high-tech arms offer considerably more freedom of movement when cutting, repairing or suturing compared to standard procedures. Because the body of the patient is precisely measured prior to every operation, the computer can create a 3D image of the surgical area. By converting the entries made by the surgeon on the PC, incisions in the range of a tenth of a millimetre are possible, something that simply cannot be achieved purely by hand. With the help of a computer, the robot is able to check at all times whether the doctor is operating where it is necessary. In case of doubt, the system can stop the doctor and thereby prevent potential medical errors.

Various systems

There is nearly no medical procedure in which a robot-supported operation would not be possible. Already today, more than 70 companies offer systems for a wide range of procedures. For example, procedures on the spinal column, the knee, the hips, in the abdomen, in neurosurgery, in the ear, nose and throat area, during biopsies, in gynaecology and urology or even in operations on the heart or in the eye. The technology is even used in hair transplants. The devices used in the operating room have different designs depending on their purpose. The bandwidth ranges from very voluminous, multi-armed systems to systems that are no larger than a beverage can. While the former is used for complex procedures, the latter system is used simply to accurately hold the instruments at the desired position.



Medical technology with drive

The patient is aware of nothing that happens in the operating room. The anaesthesia works. An anaesthetist closely monitors the vital functions. She can rely on FAULHABER for the artificial ventilation.

Operating in the turbine unit of the ventilator that is integrated in the anaesthesia system is a brushless, high-speed DC-micromotor with a diameter of just 24 mm. Not only is the motor extremely fast and quiet over the entire speed range but also extremely dynamic. This enables very natural ventilation. Adults, children and newborns can all thereby be ventilated adequately and as naturally as possible throughout the entire anaesthesia. In addition, the turbine-based ventilation allows the patients to breathe freely (spontaneous breathing) at all times.

Because robot-supported operations are being performed in an increasing number of disciplines, the need for drive systems is growing as well, such as for the positioning of robot arms. Highly dynamic systems that deliver the full speed in the shortest possible time are needed here. Thanks to their ironless winding technology and flat speed-torque curves, FAULHABER Drive Systems have all the necessary properties, such as exact positioning and speed control. High-performance motor families such as the FAULHABER BX4 or BP4 and the new BXT series,





**HIGHLY DYNAMIC
SYSTEMS**



**FEWER
ERRORS IN TREATMENT**

**1/10 MM
INCISIONS**



**24/7
JITTER-FREE
AND PRECISE**

**SIGNIFICANTLY MORE
FREEDOM OF MOVEMENT**



complemented by the extensive range of gearheads, optical, magnetic or absolute encoders as well as Speed and Motion Controllers, are ideally suited for demanding robotics applications not only in medicine but in many other areas as well.

Daily routine

Robot-supported operations are not just a futuristic vision but are daily routine in many operating rooms around the world today. Even though a tele-medical operation has already been performed – where the doctor sat at a monitor in the USA and operated on a patient in France – in practice, it generally looks like this: robot and computer serve as assistants to the people on-site in the operating room. Years of medical experience cannot simply be converted into a programming language. But surgeries can be made safer through the use of robots. And FAULHABER will play an important role. As well as outside as inside the patient.

- 1 BRUSHLESS FLAT
DC-MICROMOTORS WITH
INTEGRATED ENCODER**
3216 ... BXT IEF3-4096 SERIES
- 2 STERILISABLE
BRUSHLESS DC-SERVOMOTORS**
2057 ... BA SERIES
- 3 DC-MICROMOTORS**
1024 ... SR SERIES



faulhaber.com/en/markets/medical-laboratory-equipment

FROM A GRAIN OF SAND TO A SMARTPHONE

The central technical element of our modern world is the micro-chip. From the coffee machine to communication satellites, there is practically nothing that would function without it. Thus, the manufacture of microelectronic components is a key technology par excellence. Motors from FAULHABER play a role in all important steps here – from the processing of the silicon crystal to the assembly of PCBs.

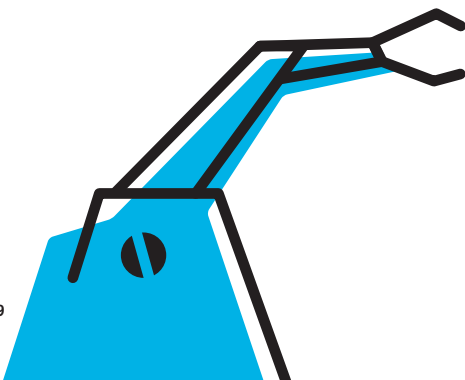


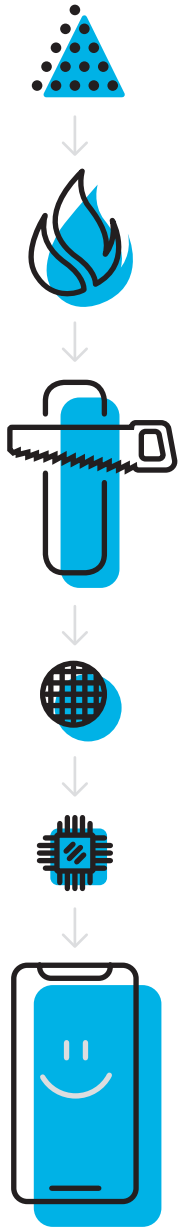
Wafers of sand

The raw material for chip manufacture could hardly be simpler: sand, quartz sand to be precise. The sand is first melted, and other constituent parts are separated from the main component, silicon. A so-called seed crystal from the same material initiates crystal growth in the liquid mass. Cylindrical rods with homogeneous structure are created. Discs about two millimetres thick are cut off from these: the raw wafers. After some smoothing and polishing, the blanks are coated with a photosensitive lacquer. The conductor paths, the thickness of which in modern chips is in the nanometre range, are created with a photolithographic process and subsequent etching of the material.

The complex structures, which connect millions of transistors on a chip to form an integrated circuit, are thereby created. Each unit is exposed up to thirty times with different photomasks. The many dozens of units on the wafer must be exactly aligned with those from the previously performed exposure. In this multi-stage process, the chip structures then appear on the round disc, which is similar in appearance to a wafer and the source of its name.

Robots move the wafers during all steps and guide them to the various process steps. The blanks are highly sensitive and must not bump into anything anywhere in spite of what are usually constrained spaces in the systems. In order for error-free structures to be created, their alignment must be extremely precise. The same holds for the optical components of the lasers in the photolithographic systems. Ensuring the precise movement of the components with reliable reproducibility in the robots and in the lasers are drives from FAULHABER, such as DC, stepper or piezo motors.





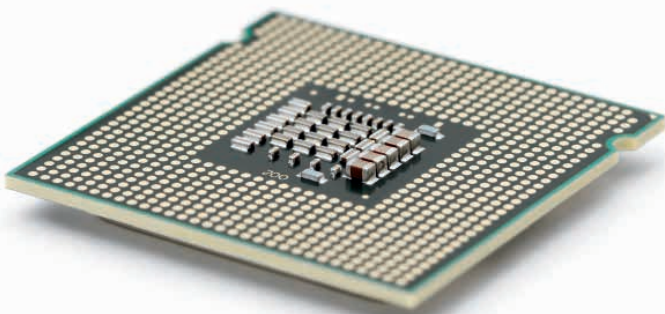
Optical
final inspection
of a typical
silicon wafer



Wire and synthetic resin

After the structures in the crystalline silicon have reached their final form, the individual chip blanks are cut from the wafers. These now receive their electrical connections (pins) in the form of fine wires made of aluminium or gold. They are unwound from rolls, a process that is, of course, also fully automatic. A special machine is responsible for this production step, the so-called wire bonding. It guides the wire end to the desired location, unwinds and cuts the required quantity and performs the soldering.

The chips are then enclosed by a protective shell, usually made from black synthetic resin. The process is similar to plastic injection moulding only that here very high precision is again required. The quantity of synthetic resin must be precisely dosed in order to effectively protect the circuit yet also ensure that nothing protrudes that could inhibit installation or function. Dosing is therefore performed by a motorised unit: the usually black synthetic resin passes through a spindle, the forward motion of which transports it toward the injection mould. After travelling an exactly measured path – in the millimetre range – the motor switches to reverse so that a precisely defined quantity of resin can be released and enter the mould. Once this process has been completed, the circuits have their characteristic appearance: the chip is now finished and is tested in the so-called test handler.





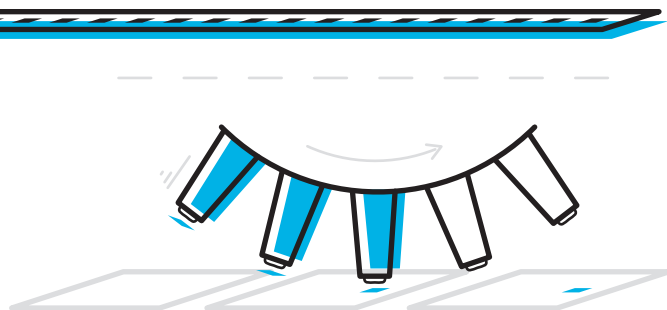
Packaging of tested parts in carrier tape

In this machine, a pick-and-place robot is responsible for transporting and placing the chips in the testing devices. Since parts are processed here that are no more than a few square centimetres in size, the dimensions of the system parts are also correspondingly delicate. The motors for their movement must be extremely compact but also be able to deliver very high acceleration values. The same applies for the wire bonding mentioned above. In both cases, the motors must perform their work with the utmost precision. Because the requirements are so high, motors from FAULHABER, such as the BX4 series with integrated Motion Controller or the portfolio of linear DC-servomotors, are used in many machines in this process area.

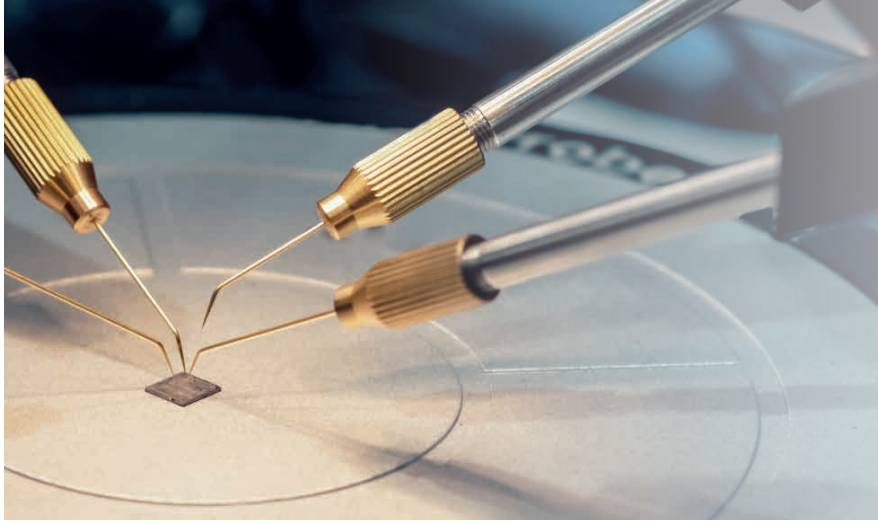
Rapid assembly and needle test

The tested chips are usually packed in plastic belts and are then transported to the next stage in micro-electronic manufacturing: to the assembly of the PCBs. You are no doubt familiar with these usually green plastic boards with chips, various other electronic components, copper conductive pathways and shiny, silver-coloured solder points – after all, we encounter them literally everywhere. Together with the components that hold and connect them, they form the small or large computer units that are responsible for flawless function not only in computers and smartphones but also in every car, in every household appliance, in every machine and in countless other products. Mass production prevails here as well: countless components are mounted on PCBs every day.

This work is performed by automatic placement machines. The belts with the components are fed to the mounting stations on rollers. Small pockets in the belt hold the components, a perforation at the edge of the belt enables precise transport. The belt is unrolled so that the placement head can always pick up one component. This last step is generally performed under negative pressure: the component is drawn in and held in the same manner. The head then moves to the location on the PCB at which the appropriate openings for the connections of the chip or other component are located. It places the chips on the openings; later they are soldered to the board.



Automatic PCB assembly using the pick & place method

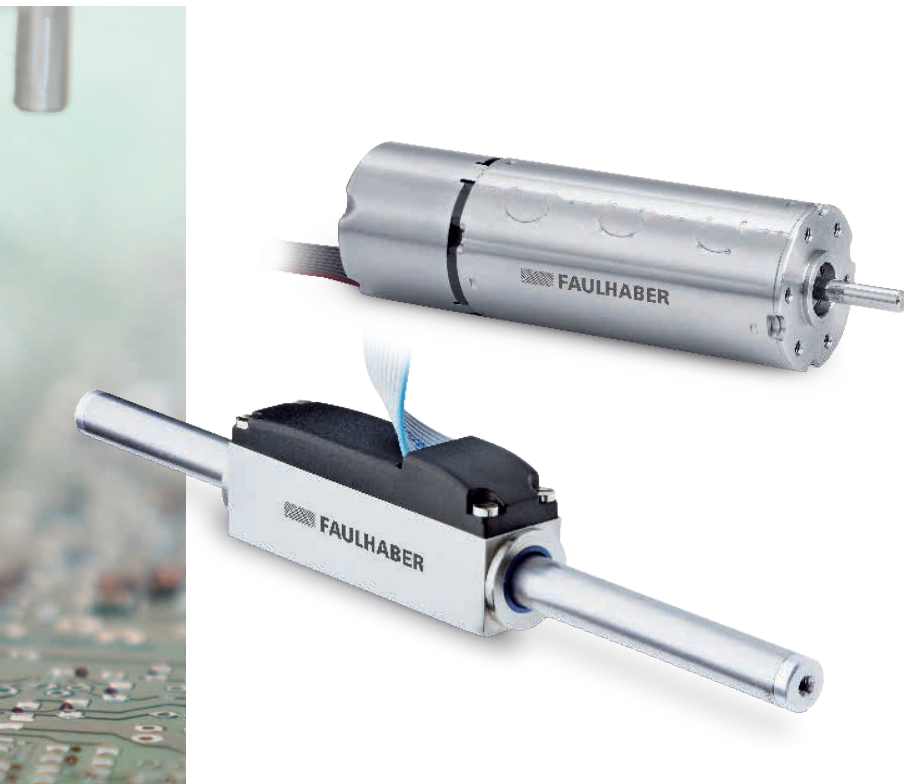


Example of chip inspection using adapter needles

It is easy to imagine how sensitive the hair-thin connections are. Any misplacement, even a fraction of a millimetre, would bend and, thus, destroy them. Here, too: precision has top priority. At the same time, a large throughput is required for the massive quantities. Some machines manage over 100,000 components per hour. The bare eye sees only the shadow of the tremendously rapid movement here. The demands on the motors that move the conveyor units and the mounting heads are similar to those in the other areas of microelectronic production.

**OVER 100,000
COMPONENTS
PER HOUR**

The subsequent quality inspection must also be extremely fast, as each individual PCB is thoroughly tested. The electrical conductivity of the connections provides information about the proper function of the circuits. To measure it, extremely small needles are guided to individual – two or more at a time – connections and placed under voltage. This is repeated for each part until all conductive pathways have been checked over. This process cannot be envisioned as a leisurely testing operation, however: the boards are often produced by the million. The fully automatic testing machines must therefore be able to handle a large throughput. The movement of the needles, for example, is so fast that it can only be followed in super slow motion.



faulhaber.com



Delicate glaze firmly in grip

Quickly determine viscosity

From smooth and creamy to light and fluffy to thick and sticky – with foods, our mouthfeel provides reliable information about consistency. Spit out or swallow?

We make this decision in just a fraction of a second. In industry, one would gladly have decisions that could be made as quickly and easily. In many sectors, viscosity tests are necessary during production in order to define and maintain optimum process parameters. That is exactly what the new rotational viscometer does, which Brabender realised with the help of a brushless DC-servomotor from FAULHABER.



With many products, viscosity is an important quality feature or is decisive for their workability in the production process. Viscosity measurements are therefore useful in many areas, in goods receiving as well as in quality control, during the optimisation of recipes or even between individual production steps. To ensure that these analyses take as little time as possible and can be completed with only small sample quantities, Brabender developed a new rotational viscometer, the ViscoQuick. Depending on the sample material, the device is able to complete a measurement in approximately 10 minutes. And can do so with just 5 to 15 grammes of sample material (plus approximately 100 to 110 g of solvent).

The viscosity characteristics of a wide range of materials are measured as a function of temperature as well as gelatinisation properties – such as of starch. The integrated heating/cooling function controls the temperatures for various applications. The reusable stainless-steel measuring pot is suitable for both acids and bases.



Fast universal measurement device: the ViscoQuick determines the gelatinisation properties of starch, the alpha-amylase activity in flour as well as the absolute viscosity of Newtonian liquids. (Copyright: Brabender)

The measurement system is controlled via the MetaBridge software; the measurements can be directly evaluated and graphically depicted. The software is web-based and networks not only the Brabender devices and their measurement results but also their users. Multiple users can log in simultaneously and conveniently exchange their data – on PC/Mac, tablet or smartphone.

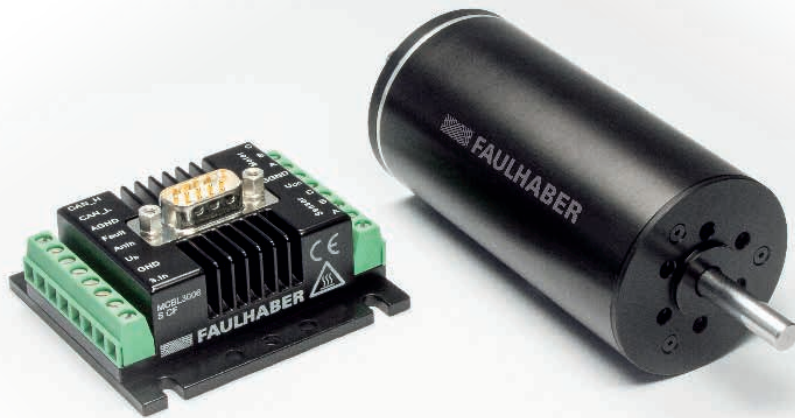
“Located underneath the measuring pot containing the sample is a motor which drives the paddle”, says Oleg Krawez, system architect at Brabender, as he describes the principle function of the new rotational viscometer. “If the viscosity of the sample changes, the torque of the drive also changes while maintaining the same speed. If, for example, starch gelatinises and, thus, the paddle encounters more resistance, the torque increases as well.”

Linear speed/torque ratio

To determine the changes, the torque is measured at the second shaft end of the motor. As a result, the motor becomes a virtual sensor, since viscosity can be determined from the torque. The speed-torque curve of the motor must therefore be as linear as possible for use in the ViscoQuick, particularly at low speeds. Depending on the analysis task, the speeds are between 0 and 500 revolutions per minute. It was therefore necessary to find the right drive.

"After extensive tests, we decided on the brushless DC-servomotor from the FAULHABER line", Krawez continues.

"The motor of the 4490 ... BS series satisfies our requirements in every regard; furthermore, we have already had good experiences with the drive specialists from Schönaich."



Motor

The 2-pole servomotor is a three-phase external rotor motor with wide speed and torque range. The integrated linear Hall sensors enable the required low speeds. Thanks to its ironless design, the motor operates cogging-free, with an absolutely linear relationship between load and speed, current and torque as well as voltage and speed and offers a highly sensitive current/torque behaviour. These motor characteristics are reflected in the measurement results. Viscosities can be determined with an accuracy of up to 0.5 cmg in a measurement range from 0 to 2,500 cmg.

Long-lasting and compact

Other important requirements on the drive were longevity and compact dimensions. After all, the motor needs to function reliably over the entire lifetime of the device as well as be easy to integrate. The brushless servomotor convinced in both regards. Due to the electronic commutation, its service life depends mainly on that of the motor bearings. Here, highly precise pre-loaded ball bearings are used which have proven their reliability in a wide range of application areas.

At the same time, the very compact dimensions of the 282 watt motor – measuring just 44 mm in diameter and 90 mm in length – were a perfect fit in the ViscoQuick's limited installation space, as the measuring device itself is designed to be very space-saving. "We were, therefore, very happy that FAULHABER also has a suitable, space-saving controller in their product line with the MCBL 3006", says a pleased Krawez. With its dimensions of 58 mm by 65 mm, the footprint of the controller, which is perfectly matched to the motor, is the size of a credit card; in terms of height, it measures only 27 mm. It communicates with the higher-level control system of the viscometer via an RS232 interface; actuation is also possible via CANopen.

The combination of brushless DC-servomotor and matched controller has proven effective in the ViscoQuick. Brabender also uses the same solution in other measuring instruments, such as in the Amylograph-E, which supplies a reliable and reproducible picture of enzyme activity (alpha-amylase) in flours and grains. Here, too, changes in torque are measured and are automatically recorded in an amylogram.



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SPONSORING





AUTOMATIC CHARGING OF EVS

While electric mobility is becoming ever more popular, there is still room for developing functional standard technologies in some areas. One such example is the way cars are charged: nobody wants to see streets littered with charging stations. And while inductive charging is largely hidden from view, it comes with some significant disadvantages. Volterio offers an efficient alternative that makes sense. The prototype of the charging robot moves using FAULHABER motors.



Charging stations can be an eyesore in inner cities, and the bulky cables and plugs can also be an inconvenience in people's garages. Contactless inductive charging with coils embedded in the garage floor or the road surface has none of these visual or mechanical annoyances. But unfortunately it comes at a heavy price, and in more than one way: making the coils disappear means the ground has to be opened up and refinished; the maximum output is currently three kilowatts in most cases, which can result in long charging times; and with this type of charging, a significant portion of the power is lost compared to plug-in cables. This loss is even higher if the car is not parked right over a coil.

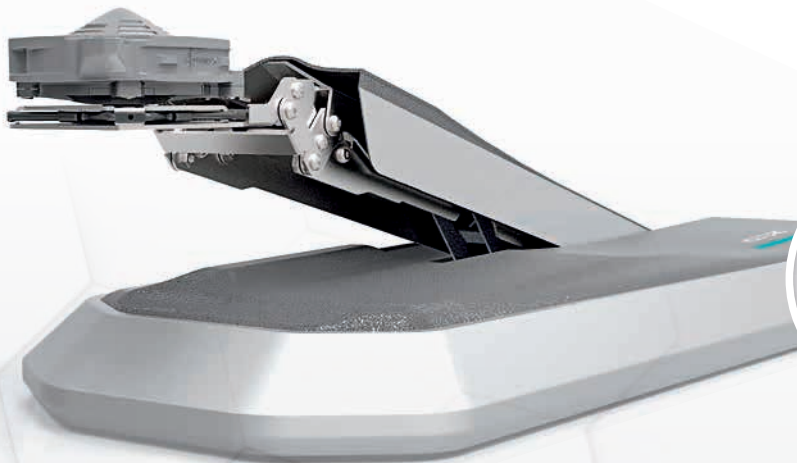
Connector finds connection

The technology from Volterio offers an elegant solution to all of these problems. When inactive, the charger is an inconspicuous, only 6 centimeter high structure on the floor. The car is then parked over it for charging. Next, a robot arm extends telescopically. At the end of this arm is a connector which seeks its counterpart on the car's underbody.

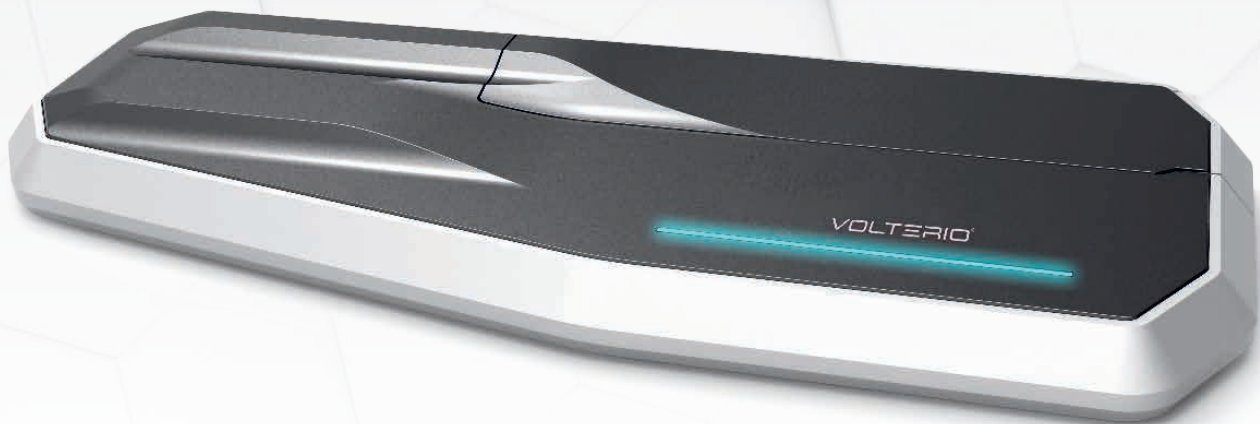
The two components have previously exchanged information with each other via encrypted wireless communication. And since the conical-round current carrier is not a connector in the traditional sense, it is still able to make full contact even if the car is not parked in the optimal position. An ultrasonic system is used to make sure that the arm accurately finds its target. The connection is established in less than 15 seconds.

The connector must simply be within a range of 50 by 50 centimeter, and the car can even be parked at an angle. It is also possible to embed the entire unit in the floor for new constructions of garages or parking spots. The charging capacity of a charger with home connection is 22 kilowatts, which means that even the largest car batteries can be fully charged in 4-5 hours. The technology itself is designed to handle up 100 kilowatts DC, which lowers the charging time to an hour.

The idea behind Volterio stems from a master thesis that Christian Flechl wrote in 2014 at the Graz University of Technology (Austria). Today, he is the Managing Director of VOLTERIO GmbH, and his product is about to go into series production. An important aspect in the development of the prototype was the three motors that move the robot arm along the three axes: "We wanted to build a device that was as flat as possible, so there was very little space available from the beginning", the young graduate engineer recounts. "At the same time, we need to move considerable weight. So the motors – in conjunction with the appropriate gearhead – have to offer high torque, high speed and be small in size."



Christian Flechl
—
Managing Director
VOLTERIO GmbH



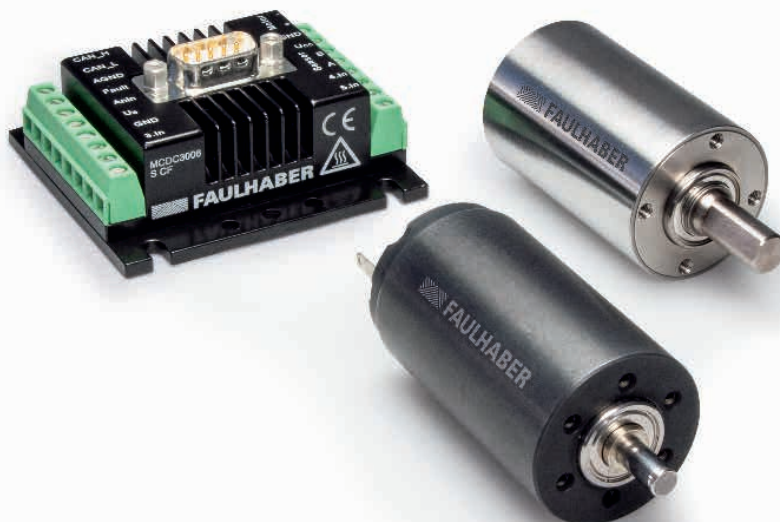
Powerful, fast, reliable

A search on the Internet quickly led him to FAULHABER, as not many companies are able to meet these types of specifications. "In talks with other experts I was reassured that FAULHABER was the way to go, and that became even more evident when we started working together. FAULHABER sponsored the entire project with extensive technical advice, selecting the right motors, and by offering the motors themselves." DC-micromotors with planetary gearheads and a suitable motion controller were installed in the prototypes. In addition to that, FAULHABER selected and provided other drives for testing purposes.

The high motor performance of the CR series is based on a very stable graphite commutation with low wear, powerful neodymium magnets, and a particularly high ratio of copper in the winding. The charging station is designed for about 20,000 cycles.

This means only about 1% of the service life of the drives is used. Their robustness is also very important, because the Volterio units must work reliably even after long standstills and in harsh weather conditions.

The prototype performed very well in extensive testing. In pivotal aspects, the technology is far superior to competing concepts. Several manufacturers of premium cars agree. They are already preparing to have the chargers go into series production. Volterio is now working on new challenges: "Automated charging processes can be used in many different ways", Christian Flechl explains. "This is true for the entire field of logistics as well as for all driverless vehicles. Solutions for electric trucks are under development as well. We are developing suitable charging robots, and we continue to rely on the valuable support of FAULHABER."



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CYBATHLON 2020

HSR TEAM POWERED BY FAULHABER



At the Cybathlon 2020 competition, electrically driven assistance systems for people with disabilities will be put through rigorous practical tests. The team from HSR University of Applied Sciences Rapperswil (HSR Enhanced) is participating with a robotic wheelchair and is being supported in the endeavour by FAULHABER, as our compact and powerful motors are predestined for this application. In the next edition of motion, read how FAULHABER drive systems are helping people both with and without disabilities overcome everyday challenges with applications like this and through other areas of human augmentation or prosthetics.



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