

motion

01.2024

THE MAGAZINE WITH DRIVE

Tenths of millimeters decide
between a champagne shower
or pit stop blues





NEWS

04 **New clout for Sales**
Even greater customer orientation

INTERVIEW SERIES

08 **Progress as a driving force**
Interview with CEO Lance Horta from FAULHABER MICROMO Clearwater, Florida

EXOSKELETONS & PROSTHETICS

14 **Walking naturally with artificial foot?**
The D-Ankle prosthesis from Design Pro Technology ensures biomechanically correct movement.

INDUSTRY & AUTOMATION

18 **Tenths of millimeters decide between a champagne shower or pit stop blues**
Team Sauber relies on FAULHABER motors to achieve perfect aerodynamics.

22 **Precise "rotation" for movement in very constrained spaces**
FAULHABER drives deliver precision and dynamics for swiveling-rotary modules.

26 **Compact automation with a perfect sense of timing**
STIWA stands for precise small and micro component production in an ultra-compact format.

NEWS

30 **New products**
FAULHABER BX4 IMC, encoder IEP3, Motion Manager 7

KNOWLEDGE

34 **Simulink® virtual drive test**
Library for simulation of drive behavior



Dear readers,

since publishing the last edition of the FAULHABER motion, despite our hopes and prayers for the contrary, relief from burdensome geopolitical tensions and a clear pathway to a more peaceful world continues to remain elusive. Our task as a company is to navigate these troubled waters as best we can and keep a clear focus on our vision of a better tomorrow. We continue to enhance our resilience and develop innovative new products and exciting new capabilities. Most importantly, we continue to enable our customers' success in the innovate and challenging fields of application that will be making important contributions to that better tomorrow.

Strategically, our organization must grow and adapt to the ever changing global landscape of our markets. We made the important decision to restructure and strengthen our sales and business development organization to ensure that we are there where our customers need us with the right products and support.

In addition we are excited to present our new clean room capabilities in Germany. This is an important step to support our growth in the areas of medical device and semiconductor automation production at the highest levels of precision and cleanliness. Whether it is the limitation of the bio-burden for medical devices or the strict limitation of particle contamination for precision optical systems, FAULHABER is prepared for the next level of production.

Lance Horta, CEO of FAULHABER MICROMO, provides an interesting perspective regarding progress in difficult times in an informative interview which shines a light on the unique challenges of the North American market and the role of FAULHABER enabling some of the world's most challenging and innovative applications.

Innovative products, high precision production processes and sound strategic decisions are key elements for the success of a company. The most important element for us at FAULHABER, however, is the close cooperation with our customers. We are excited to continue to push the boundaries of our technologies to accelerate our customers' success.

Happy reading!

Regards

Karl Faulhaber
Managing Director

Issue 01.2024

Publisher / Editor:

DR. FRITZ FAULHABER
GMBH & CO. KG
Schönaich · Germany
Phone: +49 (0)70 31/638-0
Fax: +49 (0)70 31/638-100
E-Mail: info@faulhaber.de
www.faulhaber.com

Layout:

Werbeagentur Regelmann
Pforzheim · Germany
www.regelmann.de

Picture credits & copyright:

All rights reserved. The rights for the graphics and pictures used as well as brand names mentioned are held by the respective owner. The copyright for the articles is held by the editor. Reproduction or electronic processing of content, even sections thereof, is only permitted with the explicit written consent of the editor.

Publication frequency & subscription:

FAULHABER motion is published annually and is delivered to customers, interested parties and employees of FAULHABER free of charge.

FAULHABER motion is also available in digital format:
www.faulhaber.com/en/motion



JIMBOLIA SITE GROWING

To safeguard competitiveness in the long term and to meet the demands of the increasing production volume, the site at Jimbolia in Romania was recently expanded with the construction of a new building. The production site is a key element of the manufacturing network of the FAULHABER Group. For example, activities such as gearhead assembly or balancing processes are performed there. Windings for FAULHABER bell-type armature motors are manufactured at the site too. Furthermore, the range of services includes the manufacture of modules as well as the assembly of customer-specific complete drive systems.



www.faulhaber.com/news



NEW CLOUT FOR SALES

With the new sales organization, even greater focus is being placed on customer orientation and the ability to react quickly. Responsibilities are being reallocated within the existing sales management team: Marcus Rimmel has been assigned the area of Global Market Development with the subdivisions Business Development and Market Channel Development. Volker Sprenger, previously head of Sales Germany, now also supports key customers on a global level and will continue to build FAULHABER's presence in North America. In addition to Global Sales Operations, Mireille Deckers-Strobel will now also be responsible for the important sales markets of Europe, China and Asia-Pacific as well as for global direct customers and the distribution network.



www.faulhaber.com/news



FAULHABER SA: THE **SWISS** FAULHABER FAMILY CELEBRATES A MARRIAGE

FAULHABER has been producing and distributing drive solutions at four different locations in Switzerland for more than 60 years. As part of a strategic offensive, the Swiss FAULHABER companies will now unite under one roof in order to strengthen the market presence and the competitiveness of FAULHABER in Switzerland and internationally. In future, FAULHABER MINIMOTOR SA, FAULHABER Precistep SA and the production sites in Bioggio and Grenchen will therefore operate under the name FAULHABER SA.



www.faulhaber.com/news

FAULHABER HAS ONCE AGAIN PERFORMED OUTSTANDINGLY WELL

—

This year, FAULHABER can look forward to receiving the “TOP 100” award for the fifth time. In size class C – enterprises with 200 employees and more – FAULHABER is one of the most innovative medium-sized companies in the whole of Germany. On behalf of compamedia, the organizer of the competition, the researcher Prof. Dr. Nikolaus Franke from Vienna University of Economics and Business and his team scrutinized the innovative strength of all participants. Various criteria from five categories were assessed: Pro-Innovation Top Management, Innovation Climate, Innovative Processes and Organization, Outward Orientation/ Open Innovation as well as Innovative Success. FAULHABER convinced the jury and will therefore once again receive the TOP 100 award.



www.faulhaber.com/news





FAULHABER **CLEAN ROOM**: CLEANLINESS IN PRODUCTION



To meet the special demands of products intended for the medical technology and pharmaceutical industry and to consolidate the production capacity for this sector, FAULHABER has invested in a permanently installed clean room with ISO class 7 certification at the Schönaich site. In the 90 m² facility, products will be manufactured under stringent clean room conditions. Furthermore, the modular design will allow future expansion of production capacity.



www.faulhaber.com/news

PROGRESS

AS A DRIVING FORCE

In 1961, FAULHABER decided to venture into the North American market - a big step for the business with the small drives. A decision that has proven its worth and has resulted in a successful company. Founded as MICROMO in Cleveland (Ohio), the company moved to Clearwater (Florida) in the early 1990s. An important part of the international FAULHABER Group from the outset, the company was fully integrated and renamed FAULHABER MICROMO in 2019. Ninety-three employees dedicate themselves every day to the fortunes, customers and partners of the site.

LATITUDE N 7° 54' 19.948"
LONGITUDE W82° 40' 47.629"



FAULHABER MICROMO CLEARWATER, FLORIDA

A competence center for complete solutions

What began with an idea and the founding of a company over 60 years ago is now a company that offers and sells high-performance FAULHABER drive systems throughout the North American market. Equipped with a large production facility, an extensive machine workshop and its own test laboratory, almost anything is possible in Clearwater. From the development of customer-specific solutions, to the manufacture and assembly of various components, to technical support and troubleshooting, each project follows a schedule that begins with understanding the requirements for the device, includes process development with the team and is handled in close communication with the customer until the end. Holistic project management across all departments is the focus for the best possible solution and support. As a full-service provider, FAULHABER offers the customer many advantages: Everything from a single supplier in addition to the best quality and simultaneous cost reduction.

Particular attention is paid to product and manufacturing expertise in the field of medical technology and the requirements that need to be met. This includes applications for medical imaging - such as those used for X-rays - surgical devices and surgical robots. An understanding of this market segment and compliance with the international ISO 13485 standard for medical devices are just as much a part of the standard as fulfilling the strict requirements of the FDA.





The market, the demands and the solutions from FAULHABER

For individual customer inquiries, configuration requests or applications that require special functions, the team of experienced engineers and developers has extensive know-how. Customized, customer-specific drive solutions account for around 70 % of the orders implemented, while the remaining 30 % are standard products or slightly adapted products from the FAULHABER portfolio. A fact that illustrates the requirements of the market as a whole: innovative and customized solutions are very popular with customers and partners. This applies not only to the medical technology market segment, but also to aerospace and industrial automation, which is on the rise with the increasing demand for robots.

Many different wishes and ideas, even more possibilities. In order to meet the market's demand for specific specifications, extended functions and occasionally unconventional solutions, the development team at FAULHABER MICROMO relies on proven expertise and sometimes also on an experimental approach that can be described as "trystorming": Different things are tried out to find out what best meets the overall design objectives in the short time available. Work is then carried out to optimize costs and validate the design. In industry, this process can be implemented quite quickly, whereas in medical technology, extensive validation is required due to FDA regulations. In order to try out different approaches and realize design goals, it is important to be involved early in the development process. From the idea to the prototype to the finished product, FAULHABER's experts can provide the customer and the project with close support and assistance throughout the process. Major customers and start-ups alike appreciate FAULHABER's expertise, flexibility and quality – it is not uncommon for close cooperation to develop that lasts for years.

#03

Lance Horta
CEO FAULHABER MICROMO

You have been with FAULHABER MICROMO for quite some time, first as Chief Operating Officer and then in January 2023 you took the helm as CEO. What is your assessment after just over a year at the wheel?

I have been very fortunate to be with FAULHABER for over 18 years. During that time, many wonderful achievements have been realized through investment in the team, perseverance and a spirit that success is the only option. COVID, political tensions and economic uncertainty have led to enormous challenges all over the world in the recent past, including critical circumstances that occurred overnight and without warning. Based on our core values, we were able to achieve new important milestones during this turbulent and uncertain time. We have remained very strong and prepared for future success and growth.

How did you experience the COVID-19 period and what opportunities or hurdles did it bring for the business?

Without question, the impact of the coronavirus affected all areas of life. Perhaps the biggest hurdle to overcome was the fear of the unknown. We had to deal with rapidly changing information and regulations during this time and faced great challenges with little knowledge. In everything we did, the safety of our employees and customers was paramount. However, we were also pleased that we were able to make a contribution with our products and help in the current situation. Although we were faced with challenging delivery deadlines and quantities, we wanted to give our customers the confidence that FAULHABER is strong and reliable as a strategic, long-term partner. And, we were also able to gain new business in the medical sector, which has brought us good capacity utilization and growth.

Lance Horta,
CEO FAULHABER MICROMO





Give us an insight: How do the American and European markets differ?

From a technical perspective, American engineers focus on rapid development, often emphasizing innovation, flexibility and adaptability in project execution. In contrast, the European market, with its strict regulatory framework and emphasis on sustainability, requires engineers to consider regulatory compliance and environmental considerations, resulting in a more methodical and sustainable product development process. Both markets require a high level of technical skill and innovation, but the approach and project delivery priorities reflect the different business cultures and regulatory frameworks in the US and Europe.

Where do you see great potential in the future – in the company's orientation, in new developments or in the market?

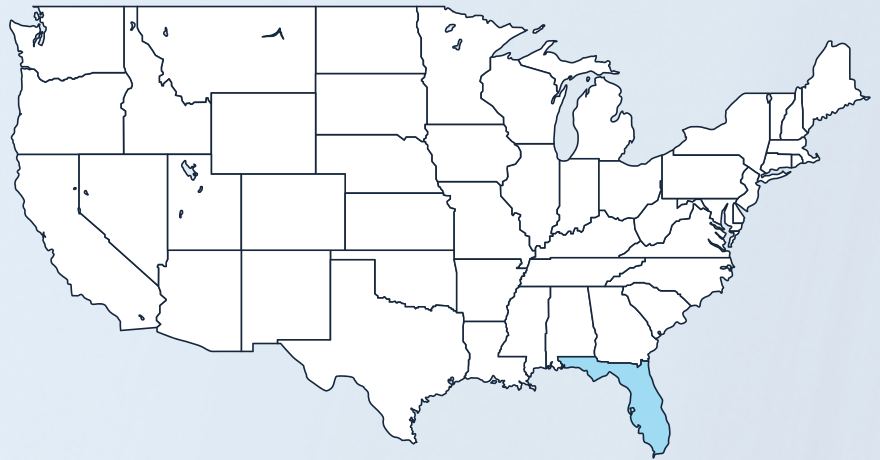
FAULHABER has always been a technological leader. Our recently released philosophy and core values underscore this position of continuing to invest in technologies that enable the world's latest innovations. We have recently launched new product families and we have more new generations of motors in the pipeline for this year and next. I am convinced that these products, together with the latest BXT and GPT product lines, will give us an advantage in the market.

And, where do you see particular challenges or trends?

I think one of the challenges is staying true to our core values without being distracted by external influences. As one example, I see many articles and studies asserting what is most effective: remote work and/or hybrid working as part of the big return-to-office debate. Additional studies look at what employees value most like flexibility, pay, benefits, company culture or purpose. Our core values have always been investing in and caring for our team members. By adhering to these core values while understanding external influences, we will continue to be able to make the best decisions.



FAULHABER MICROMO CLEARWATER, FLORIDA



As drive experts, we are able to offer our customers tremendous added-value and knowledge in value analysis and value engineering. Our assembly and manufacturing capabilities enable customers to reduce costs, risks and supply chain complexity when working with FAULHABER. In the future, the use of the newest artificial intelligence solutions available could help us providing innovative solutions and excellent value to customers, including the opportunity to expand our customer base more efficiently.

What do you wish for the future of FAULHABER MICROMO?

We want to continue the long-lasting legacy of innovative, significant and world-changing applications made possible by FAULHABER drive solutions. In doing so, we want to be an organization where people spend their careers adding to the FAULHABER legacy and then retire while fulfilling their own personal goals and dreams. Ideally, this will result in the achievement of sales targets year after year.



And one final question: What fascinates you most about FAULHABER products or a particular application?

I think it's impressive what is achievable and what power is contained in these very small drive systems. With the ability to perform extremely precise and controlled movements, it is possible to improve a patient's surgical outcome, quality of life, or even lead to a cure for their medical condition.



www.faulhaber.com/de/motion/

Walking naturally with artificial foot?

The newly developed D-Ankle prosthesis from Design Pro Technology ensures biomechanically correct movement with each step and on any terrain. This allows people with transtibial amputation to walk more harmoniously with greater stability and less fatigue. A brushless motor from FAULHABER is responsible for providing the necessary drive.

The loss of a leg or part of a lower limb can have many causes. With younger people, the cause is usually a birth defect or an accident. With older people, it is more often cancer, infections and chronic circulatory disorders; the latter is frequently triggered by diabetes. Millions of people are affected worldwide, mostly through the loss of the lower leg. From archeological finds in Egypt and China, we know that attempts to substitute missing body parts with prostheses have been made for at least 3000 years. The stereotypical peg leg from pirate films provides a realistic representation as to what leg prostheses looked like in the past. They were made of wood and leather, were intrinsically stiff and gave their wearers in a limping gait.

From pirate's peg leg to high-tech orthopedic device

Old prostheses can hardly be more different from today's prostheses because modern artificial limbs have joints, controlling algorithms and spring-loaded elements made of high-tech materials. With their help, the gait pattern becomes much more natural.

Some are even designed for maximum performance: athletes with transtibial amputations who use carbon prostheses achieve outstanding times over short distances. There have even been serious discussions as to whether the enormous spring force of these carbon-fiber constructs gives amputee athletes an advantage over "normal" runners.

Sport prostheses are designed for fast running, but standing still and performing normal activities while wearing them is difficult, even impossible. Ankle joint prostheses intended for everyday use therefore have a completely different design to the arched "skids" used in competitive sports. Usually mirroring natural anatomy, they consist of a lower leg component and a foot component, connected together by a joint. The passive artificial ankle joint ensures that the prosthesis always remains in a predictable position, however, it allows a very limited range of movement during locomotion.



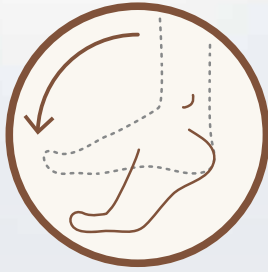
As the foot recoils – during forward movement – the foot is pressed towards the lower leg; once the foot is kicked out, the elastic force returns the foot to a near perpendicular fixed starting position. “However, this fixed position does not correspond to the natural position of the foot during the transfer phase. There is a risk of the tip of the prosthetic foot getting caught on the ground or on small obstacles,” says Marcin Dziemianowicz. The engineer, whose focus is on biomechanics, founded Design Pro Technology in Białystok (Poland) in 2016 to find innovative solutions for such problems. With an interdisciplinary team consisting of engineers, orthopedic technicians, doctors and designers, the medical technology company develops and manufactures individual orthopedic aids that incorporate the very latest technology.



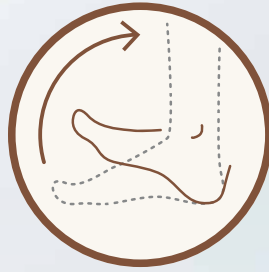
Active dorsal flexion to reduce the risk of tripping

With its new product D-Ankle, Design Pro Technology has created the first ankle joint prosthesis that actively moves the foot with a motor when walking and holds the foot in an anatomically natural position during the course of each step. Here, so-called dorsal flexion – the bending of the foot toward the tibia – during the swing phase is of crucial importance. “Increasing the distance between the tip of the toe and the ground decreases the risk of tripping,” explains Marcin Dziemianowicz. “With a passive prosthesis, the wearer achieves this by making a circular movement with their hip or by lifting their leg higher. These compensatory movements are unnecessary with D-Ankle; walking becomes more natural and less tiring.”





Dorsal flexion



Plantar flexion

When the prosthetic foot is set down on the ground, its mechanics will perform the natural change in angle during the support phase. D-Ankle is the only prosthesis with active heel-to-toe recoil functionality, including pushing off from the ground for the next step. Here, the motor-driven plantar flexion is activated, i.e. stretching in the joint. This also contributes to a harmonious gait and saves energy. Although the artificial hinge joint is unable to perform the lateral movements that a natural ankle joint allows, they are made possible as passive deformation through the elastic material of the prosthetic foot – carbon fiber. As a result, the foot achieves full sole contact even on uneven surfaces.

The controller detects the gait rhythm

The integrated controller of the prosthesis receives signals from several sensors in order to distinguish between the different phases of a step cycle. A potentiometer measures the angle between the foot and lower leg; a bilateral pressure sensor measures loading at initial contact of the foot as well as unloading in the transfer phase. The accelerometer unit detects the overall movement including speed, foot inclination and path gradient.



"The algorithm merges the signals from few most recent steps and evaluates them," says Marcin Dziemianowicz, explaining the operating principle. "From this data, it derives the gait rhythm and the optimum foot position for each step phase. For example, the ankle joint is bent more when walking uphill than when walking on a level surface, and also the take-off force is increased to make walking uphill easier. On downward slopes, it's the other way round so that the best possible contact between sole and ground can be achieved. Furthermore, a smartphone app can be used to adjust parameters such as take-off force, the sensitivity of the pressure sensor or the length of a step cycle phase."

Sporty drive with great endurance

The integrated drive ensures that the control signals are converted into the appropriate movement. At its heart is a brushless motor of the BP4 series from FAULHABER, the power of which is transferred to a lead screw. Motor and lead screw rotate in both directions and thus achieve active dorsal and plantar flexion of the foot. The high energy efficiency of the drive enables an operating time of 12 hours on one battery charge. The motor also tolerates the considerable generation of heat that can occur in everyday operation.

"Our objectives were altogether quite sporty," recalls Marcin Dziemianowicz. "The motor was to be able to emulate a jogging motion – with three steps per second, or three complete cycles of dorsal and plantar flexion. Furthermore, rapid changes in pace and direction were to be possible. For this application, you need very high speed and high torque in the smallest possible volume and with the lowest possible weight. We tried out various drive solutions from leading motor manufacturers. With FAULHABER, we not only found the most suitable product, but also received outstanding technical support."

After extensive and successful trials with test amputees, the foot prosthesis was introduced onto the market at the end of 2023. Its standard adapter allows it to be attached to any modular prosthesis stem.

Individual prosthesis adjustment is carried out by an orthopedic technician. The height of the heel can be varied so that D-Ankle can also be worn in women's heeled shoes. Should the battery charge not be enough after a very long day, the wearer can continue to walk as they would with a passive prosthesis.

"With active movement of the foot, we are quite literally making huge steps both toward natural movement anatomy and toward improved support of amputees," says a pleased Marcin Dziemianowicz. "After the experiences with this product and the great cooperation with FAULHABER, we have a number of ideas on how to utilize the compact motor power for other prostheses."



FAULHABER BP4
BRUSHLESS DC-SERVOMOTORS



www.faulhaber.com/en/motion/
www.designprotechnology.com

Tenths of millimeters decide champagne shower or pit stop

The perfect balance between minimum drag and optimum downforce can decide whether there's a party atmosphere or a somber mood of crisis in the pits at the end of a race. With the help of extremely precise FAULHABER motors, the aerodynamics engineers of Team Sauber are on the hunt for the perfect setup.

Five tonnes of thrust

Anyone wanting to take part in Formula 1 works practically non-stop on improving the car and on finding the best possible setup for the next race. From 2026, Sauber will be the Audi works team and compete in the F1 championship. At present, the Swiss motorsport experts are part of the Alfa Romeo F1 Team Stake. To fine-tune the best possible aero-

dynamics setup, they have their own wind tunnel in Hinwil, not far from Zürich (Switzerland).

The steel-built facility is a closed loop measuring 140 meters in length. Inside, a 3000 kilowatt turbine generates a thrust of up to five tonnes. This artificial wind is transformed into a uniform airflow by rectifier

between a blues



elements in the form of grids and honeycombs and guided into the test chamber. There it pushes against the outer skin of the model car, simulating the drag that occurs under actual race conditions. "According to the rules, we are not allowed to test the race-car itself," explains Peter Herrsche, who manages the Sauber Group's wind tunnel. "However, using a model also has significant advantages because it allows us to work much more flexibly and efficiently. Unlike the actual car, the model also has enough space inside for the measuring instruments that we need to obtain detailed information from the tests."

The model car is 60 percent the size of the original and is roughly three meters long. In the wind tunnel, it stands, or rather "moves", on a "rolling road". This is a moving belt with imitated race-track surface – which is, as the experts assure us, incredibly expensive – that can be operated up to 300 km/h. Sophisticated attachment to a movement system ensures that the model can simulate all active maneuvers that a car performs on the track, from acceleration and braking to cornering and drifting. The turbine delivers the headwind corresponding to the speed of the rolling road. An aerodynam-

ically generated downforce acts on the tires. The drag affects the car as it would in a real race – e.g. in a completely different way when cornering than on long straights.

"The DRS may be used on only a few sections of the racetrack," explains Peter Herrsche. "However, this wing position can make a difference of up to 25 kilometers per hour when overtaking." DRS stands for Drag Reduction System: Changing the angle of the top scoop on the rear wing reduces drag. The complicated Formula 1 rules permit this only at precisely defined points and when the distance to the car ahead is not more than one second.

Regardless of whether overtaking is successful or not – the wing folds back down immediately after the incredibly fast maneuver has been completed, and drag and downforce increase again. The perfect balance between these two variables is different for each racetrack. The aerodynamics specialist continues: "On the extremely fast Monza circuit, for example, we want drag to be as low as possible, but on the narrow streets of Monte Carlo we need lots of downforce."



Measuring instruments plus buttometer

Up to 350 measuring points in the form of dynamic pressure probes record the pressure distribution over the surface of the model. The forces that occur at the tires, front wing and rear wing are measured using special scales. In a test sequence lasting 15 to 20 minutes, up to 70 items such as the wing position or the behavior of the underbody are tested. Variables such as full and empty fuel tank or new and worn tires are also simulated.

Furthermore, the aerodynamics engineers constantly exchange information with the racing team during the training sessions on the racetracks. Although the driver's own "buttometer" doesn't deliver any accurate data, it does provide indispensable information to help find the optimum setup. "The driver is the one in the hot seat, so ultimately the car needs to function in the way that is best for him," emphasizes the wind tunnel manager. "His feedback is therefore also a very important variable for us."

The objective is always the lowest possible drag with an as evenly as possible distribution of downforce, and this during all driving maneuvers and in all imaginable situations. "You have to imagine the car itself as a set of scales," says Peter Herrsche, describing one of the particular challenges of testing. "When braking, the nose drops and the effect of drag changes accordingly. At the same time, the underside of the vehicle – on a racecar this is always very close to the ground, and on the model the distance is another 40 percent less – must not come into contact with the rolling road. At the defined test speed, this would cause enormous damage to the model and the moving belt. We have to be able to dynamically control this pitching motion of the model precisely to half a millimeter."

No time for technical problems

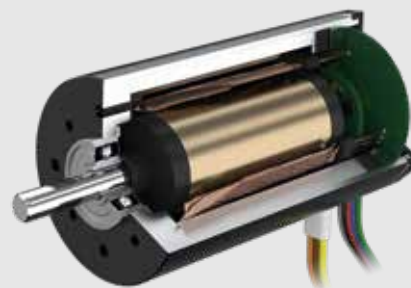
This means, for example, adjustment of the wings has to be accurate to within one tenth of a millimeter. This is where the motors from FAULHABER come into play. A total of eight drives are used in a test run. Six of them move the attachment and control elements, and two are responsible for the wing angles. Where space in the model is particularly limited, the brushless DC-motors of the 1226...B series are implemented. Where more room is available, the larger 2264...BP4 model with the MCBL3002 motion controller is used.

These drives deliver the necessary torque from the smallest possible volume and can be installed even in constrained spaces. To adjust the attachment of the model to the wind tunnel ceiling, Sauber uses the most powerful brushless motor from the FAULHABER product range: the 4490...B model, also with a motion controller, in this case from the MCBL3006 series.

The precision of the drives is at the top of Sauber's list of requirements. However, this is followed closely by durability and reliability, as Peter Herrsche underlines: "On the one hand, the rules limit the duration of the test runs in the wind tunnel. At the same time, in the Formula 1 season, the next race that we need to prepare the car for is always just around the corner. We can't waste a minute – the used technology simply has to be 100% reliable. The motors from FAULHABER have helped make sure of this for many years, and we are extremely pleased with them."



FAULHABER BP4
BRUSHLESS DC-SERVOMOTORS



FAULHABER B
BRUSHLESS DC-SERVOMOTORS



www.faulhaber.com/en/motion/
www.sauber-technologies.com

Precise “rotation” for movement in very constrained spaces

With their compact, high-torque swiveling-rotary modules, the kinematics specialists from Jung Antriebstechnik und Automation ensure highly dynamic handling for rotary, swiveling, screwing and winding applications. FAULHABER motors provide the precision and necessary torque for these modules.

Anyone looking for an efficient and space-saving solution for typical movement sequences that occur in handling and assembly technology, such as turning, swiveling, screwing, rolling or coiling, may be interested in the swiveling-rotary modules of the ForTorque series from the kinematics specialist JA² (Jung Antriebstechnik u. Automation) based in Wetzlar, Germany. This is because the slimline infinite rotary units are ideal for the highly dynamic rotation of large, high-inertia workpieces and eccentric grippers as well as for use in screwing and coiling technology.

Turning, swiveling, screwing, coiling

A typical application case for the miniature swiveling-rotary modules is, for example, screwing the caps on small cosmetics or pharmaceuticals containers in constrained spaces on fully automated packaging lines. The modules are also suitable in cases where grippers or workpieces need to be swiveled, e.g. when assembling or separating products.





The fast rotary units can be combined with linear axes. The result are compact lift-rotary or lift-swiveling systems through to five-axis handling systems.

Designed as a modular system, six sizes with diameters of 16, 20, 25, 35, 40 and 45 mm are available. This covers peak and continuous torques of 0.3 and 0.14 Nm to 4.0 and 2.6 Nm respectively. The inertias of the load may be between 2.0 and 200 kg m². This provides the most suitable solution for accurately angled movement and positioning for a wide range of different handling and assembly tasks.

To reduce the load on the output shaft of gearheads in the case of high external moments of inertia, the output plate of the four larger module models has an extremely rigid bearing consisting of two thin-section bearings. Furthermore, the swiveling-rotary module with 40 mm diameter can additionally be

equipped with a fluidic rotary joint for pneumatics or vacuum, e.g. to supply a pneumatic gripper with compressed air. The kinematics specialists push the modular concept even further: An interesting possibility is to combine the fast rotary units with linear axes, e.g. of the QuickLab series. Matching adapter plates are available as accessories. The result are compact lift-rotary or lift-swiveling systems through to five-axis handling systems.

High dynamics and precision

“The drives are the heart of our modular automation system and the requirements placed on them are very high,” explains Wilhelm Jung, Managing Director at JA². “The motors must operate highly dynamically, be precisely controllable and have suitable dimensions.” In the case of the ForTorque modules, for example, the brushless DC-motors of the B and BX4 series from FAULHABER proved convincing. The motors with their two-pole and four-pole technology are extremely compact.



Single-cable technology for fault-free control

All swiveling-rotary modules are connected and controlled using a standardized bayonet connector, single-cable technology and a motion controller. In automation systems, however, the switch cabinet is usually some distance from the actual drive. "Between the motor and the controller in the separate switch cabinet, there can then be 10, 20 or more meters," says Wilhelm Jung. There is therefore a special, multi-shielded cable that transfers the motor power and the position sensor signal between motor and controller up to 30 m without interference. The cable is fastened with strain relief, can be plugged in and is also designed for use with cable chains, i.e. for mobile use. Moreover, thanks to the available preassembled cable sets, the single-cable technology simplifies installation.

With the motion controllers, the user has the choice because the used motors are compatible with different controllers. "We also offer motion controllers from FAULHABER," adds Wilhelm Jung.

The used variants of the B series with diameters of 16, 20 and 35 mm are just 28, 36 and 68 mm long respectively, but deliver continuous torques of up to 168 mN in the case of the largest variant. Similar also applies to the BX4 series. "Here we use motors with 22 mm or 32 mm diameter and continuous torques of 18 and 53 mNm respectively," reports Wilhelm Jung.

The motors are used in the ForTorques up to speeds of 8,000 rpm. Different gearheads, including zero backlash planetary gearheads from FAULHABER, provide gear reduction. Ultimately, the gearhead technology with the respective maximum input speed determines the limit for the maximum motor speed. "We then select the reduction ratio according to the application," continues Wilhelm Jung. "In this way, we can influence the extent to which the external moment of inertia is reduced by the square of the reduction. The motor can then be precisely regulated unaffected by the lever. When selecting the gearheads, we paid particular attention to the efficiency of the gearheads. Because the better the efficiency is, the more precisely the torque applied at the gearhead output can be determined from the motor current. This is a key feature particularly in the case of screwing applications where delicate (plastic) parts need to be screwed on with a defined torque."



The two companies have, after all, enjoyed successful collaboration for many years. In the above-mentioned QuickLab linear axes, for example, the DC linear drives LM2070 and LM1247 are used. They are not designed as classic "surface rotors" with carriages and guides. Instead, theforcer rod is guided within a 3-phase self-supporting coil. "This design produces an exceptionally good relationship between linear force and current and high dynamics. In addition, there are no cogging torques, thereby making the linear motors ideal for use in our modular QuickLab system," concludes Wilhelm Jung.

About Jung Antriebstechnik u. Automation (JA²)

JA² GmbH, based in Wetztenberg north of Giessen (Germany), is regarded as an expert technology partner for users from the machine construction sector and manufacturing industry. The implementation of customer requirements and customer demands using the very latest drive technology is foremost. Application-specific complete solutions are offered



for machine and plant construction and for the processing industry. The focus is on highly dynamic applications that also satisfy all demands in terms of positioning accuracy. The ForTorque system for swiveling-rotary applications is part of an overall mechatronic program that currently includes a large selection of linear motor servo actuators and rotary servo actuators for implementing efficient single-axis, pick-and-place and portal solutions for handling and assembly technology across all industries.



FAULHABER LM 2070
LINEAR DC-SERVOMOTORS



www.faulhaber.com/en/motion/
www.ja2-gmbh.de



Compact automation with a perfect sense of timing

The modular LTM-CI system from the Austrian machine manufacturer STIWA stands for precisely choreographed small and micro component production in an ultra-compact format. Motors from FAULHABER provide the reliable drive and ensure correct timing.

The valve consists of just a few components and is only eight millimeters long. It is part of the anti-lock braking system of a large automotive supplier and is required in seven-digit quantities every year. Production must run with a takt time of half a second in order to cope with this volume. Of course, this happens fully automatically and at such a speed that the human eye can barely keep up with the individual assembly steps.

Small parts in a narrow Alpine valley

The individual parts are first fed from storage containers, separated using a shaker and correctly positioned on a conveyor system ready for the first manufacturing step. The components are then transported to the respective station where delicate grippers pick them up and join them together or process them in some other way. If you watch the



machine go about its work, you will witness a fascinating choreography, which combines smoothly flowing transport of the conveyor belts and the rapid, jerky movements of the grippers into an intricate, rhythmic dance.

The machine that executes these complex movements in precise synchronization is a compact automation of the LTM-CI series from STIWA. It is designed for products with a spatial diagonal of up to 30 millimeters – and is itself the result of drastic miniaturization, as Roland Schiermayr, Departmental Head of Automation Research and Development, explains: “A customer in the west of Austria produces dampers for a well-known furniture retailer that needs millions of these parts every year. The company wanted to buy a new production machine. The existing machine was 10 meters long – for the production of small components measuring just a few centimeters in length,

this was simply too much for the production site in a narrow Alpine valley. This was the impetus for us to fully utilize all miniaturization possibilities.”

The result of the development phase was the above-mentioned compact machine, or more precisely an automation platform which, depending on the configuration and equipment fitted, manages with a length of 3 to 4 meters. A rigidly linked transport system forms the basis, and the other system components depend on the needs and specifications of the customer. “We can integrate up to 22 function modules, each measuring 90 millimeters in width, for different work steps,” explains Christian Mersnik, who was involved in development from day one. “These functions include, for example, pick-and-place, laser welding with up to five degrees of freedom, screw insertion, press-in operations, labeling as well as testing and measuring processes.”



Power density that is unique worldwide

The compact automation has been well received by the customers. They appreciate, among other things, the uniform, smooth movements without impacts or vibration, which guarantees a stable process; one regular customer reports that the system runs "like a sewing machine". With the LTM-CI, the cycle times have been reduced to almost just half a second, which brings with it a significant leap in productivity.

The drives used in the actuators inside the machine make a major contribution to the smooth movement as well as the high speed. In earlier generations, electric motors of a completely different size class were used; for the compact automation, the developers discovered the products from FAULHABER.

In the LTM-CI, the LM 1247 linear motor now plays a key role. It performs its task at up to twenty points in the system, including stopper units – sliders that interrupt the flow of material – and grippers. One particular strength of the FAULHABER linear motors is their extremely high speed. This drive also delivers an enormous thrust: At just 12.5 mm wide and 19.1 mm high, it produces a continuous force of 3.6 Newtons. "When operating at full power, it can even manage 10.7 Newtons," points out Roland Schiermayr. "There is no other small linear motor with this power density available on the market anywhere in the world."

Longevity is what makes the real difference

The engineers from STIWA heap equal praise on the brushless motor of the 2250...BX4 series. In the portal handling of the compact automation, this motor drives the swivel units that move the tools or components to a specific position. When selecting a suitable drive, in addition to the typical strengths of the FAULHABER motors, the availability of an accessory part was also an important factor, as Christian Mersnik explains: "At this point in the system, we require an extremely high level of precision and repeatability. This is why it was an important argument for us that FAULHABER was able to deliver this motor with a matching multitrans absolute encoder. The signals from this encoder are necessary to achieve the high production quality and for quality assurance."

For STIWA, however, it is the longevity and long-term reliability of all components that make the real difference. This is because the company guarantees its compact automation customers fault-free operation of no less than 60 million strokes. This huge number must therefore also be achieved by all moving parts – and this, of course, includes the motors. "We subject our own parts as well as additionally purchased components to endurance tests," explains Roland Schiermayr. "In these tests, we attempt to destroy the parts through wear and unfavorable conditions. Only those parts that survive the endurance tests are installed in the machines. The motors from FAULHABER have shown that they can meet such extreme requirements. They help us to achieve our own peak values with minimum space requirements and the shortest cycle times."



About the STIWA Group

In the space of 50 years, thanks to high-tech solutions the STIWA Group with headquarters in Attnang-Puchheim has developed from a one-man business in Upper Austria into a worldwide automation specialist with more than 2,200 employees at twelve locations on three continents. Its fields of activity include, for example, automotive, electronics, light industry, medical technology, fittings and building automation. In the automation segment, STIWA offers modular and scalable assembly systems for real-time-capable production. The miniature automation solutions achieve cycle times in the sub-second range. STIWA's customers include internationally active companies such as Volkswagen, Bosch, Magna and Greiner.



FAULHABER BX4
BRUSHLESS DC-SERVOMOTORS
4-POLE TECHNOLOGY



www.faulhaber.com/en/motion/
www.stiwa.com

MAXIMUM CONTROL WITH MINIMUM SPACE REQUIREMENTS



FAULHABER IMC: The world's smallest Integrated Motion Controller

Integrated in the powerful brushless motors of the FAULHABER 22...BX4 family, the new IMC Motion Controller measuring just 18 mm in length impresses with its extensive range of functions and outstanding performance. The version with RS232 interface is ideal for integration both from a PC and via an embedded master. In the CANopen version, the Motion Controller can be integrated into industrial automation networks without problem. Alternatively, both versions can also be operated without a master in "stand-alone" mode.

The compact drives can be combined with many components from the FAULHABER product range such as the particularly compact GPT gearheads and the new FAULHABER 22L linear actuators.

Compact complete solution "ready to use"

The diameter-compliant design provides users with a complete solution that saves space and resources as well as wiring requirements. Simply connect to the application and get started.

Commissioning is easiest using the free Motion Manager 7.1 software from FAULHABER. To allow you to start straightaway, programming adapters for RS232, CANopen and USB are available as accessories. The brushless motors with the new integrated Motion Controller IMC are available in different lengths with first-class volume-to-performance ratio as well as highly dynamic control characteristics. They are suitable for a multitude of different application areas, such as medical and laboratory technology, automation technology, robotics or special machinery construction.



FAULHABER BX4 IMC
BRUSHLESS DC-SERVOMOTORS WITH
INTEGRATED MOTION CONTROLLER



www.faulhaber.com/imc/en

SENSITIVE POSITIONING IS THE KEY



The IEP3 incremental encoder is a new addition to the FAULHABER product range – thanks to the very latest chip technology, it achieves an extremely high resolution and accuracy.

With a diameter of just 8 mm, the IEP3 is very light-weight and compact offers a resolution of up to 10,000 lines per revolution. In the standard version, the resolution is freely programmable from 1 – 4,096 lines per revolution. Moreover, the chip technology that is used ensures a high positional accuracy of typically 0.3 °m as well as a high repeatability of typically 0.05°m thanks to accuracy compensation. The IEP3 can be powered with a supply voltage of both 5 V and 3.3 V. This makes it suitable for use in battery-powered applications as well, which are typically operated with 3.3 V. A wide temperature range of –40 to +125 °C likewise opens the door for various possible uses.

Various options are available for the electrical connection of the encoder, such as PVC or FEP cables, connector options as well as different cable lengths. Versatile, compact, accurate – the IEP3 is suitable for a wide range of different application areas, e.g. for prosthetics in the field of medical technology, for optical applications, such as telescopes, microscopes, lasers or cameras, for semiconductor production or robotics.

Compatible and compact design

The ON-axis encoder with 2-pole-sensor magnet is simple in design and robust. Thanks to its modular characteristics, which FAULHABER already established with the IE3 encoder series, the IEP3 encoder represents a platform for various motors from the drive specialist. The new product can be combined with DC-motors of the 0816SR, 1016SR, 1024SR series as well as with the stepper motors of the AM0820, AM1020, AM1524 series.



FAULHABER IEP3
INCREMENTAL ENCODER



www.faulhaber.com/IEP3/en

SIMPLEXITY – USABILITY HAS A NEW NAME AND FAULHABER HAS THE APPROPRIATE SOFTWARE

The analysis and evaluation of trends and megatrends tell us which topics will be relevant in future – for the economy, for politics and in everyday life.



Anyone who follows which major topics are currently “trending” is sure to have come across the term “simplicity”. Composed of the two words “simplicity” and “complexity”, it is at first glance a combination of two opposites. Essentially, the term encompasses the desire for simple and intuitive operability of complex systems and programs, and the associated user-friendliness. In other words, even if applications themselves are becoming more complex – because as a result they then offer greater performance and added value – they should still remain simple to use for the user. Behind this is a further, everyday idea: Simple usage means greater satisfaction and efficiency. Simplicity has developed into a mega trend and will have a decisive influence on tomorrow's applications.

Analogue products, networked technology, digital solutions

With an extensive product range and thanks to innovative technology, drive solutions from FAULHABER also offer an increasing number of possibilities. This means that in modern automation technology, for example, networked solutions are now the state-of-the-art. Equipment manufacturers face the challenge of integrating drives in heterogeneous systems in which 50 W servomotors operate on equal footing directly next to drives with multiple kilowatts of power. Here, the interface used to integrate the drive configuration and the requirements to be met are individually adapted to the application. Irrespective of how complex the system is, it must nevertheless remain easy to commission and operate.



How can the usage of drive solutions be easily implemented in the sense of simplicity?

In essence, FAULHABER addresses the requirements from the heterogeneous systems with significantly expanded product support. Users from robotics and machine construction are experts for their specific processes; the details of the drive configuration do not usually belong to their core competences. Great value is therefore placed on as simple commissioning as possible – and this is where the free FAULHABER Motion Manager comes in. This software provides users with extensive support for commissioning and configuring FAULHABER drive systems. The graphical user interface makes uniform and intuitive procedures possible independent of the product family and interface used.

Simple management across the board – with Motion Manager 7

In addition to a newly designed area for easy commissioning and configuration of the drive systems, the new Motion Manager 7 also includes various tools for controlling and observing the drive behavior, a development environment for sequence programs and a maintenance area for diagnostics and firmware updates. Thanks to the new attractive interface and the new functions, operation and configuration become child's play. In addition, anyone wanting more support or who has specific questions can utilize the possibility of remote maintenance. Furthermore, FAULHABER MC Support is available in the case of specific programming and application cases.

The following controls are supported by Motion Manager 7:

- The MC V3.0 family
- MC 5010/5005 S
- MC 5004 P
- MC 3603 S
- MC 3001 B/P
- MCS 3242/3268 BX 4
- MCS 3274 BP4
- as well as the new 22xx...BX4 IMC



The interfaces with USB, CAN (supported interfaces: HMS-IXXAT, Peak) and RS232 (COMx) are also supported.

Upgrade now!



Motion Manager 7



www.faulhaber.com/moman7/en



SIMULINK

VIRTUAL DRIVE TEST



How will the drive actually behave in the real-life application? For brushless DC-motors from FAULHABER, this question can be answered without any hardware whatsoever. They were recently added as virtual modules to a library and can be integrated into modeled applications using the simulation software Simulink®. The simulated behavior serves as an indicator for the real-life situation. It takes just a few clicks to “try out” different drives. This makes the development process much easier.

Let us take a transport drone used in logistics as an example. Its drives need to meet high dynamic demands to enable precise and responsive control of the flying object. They must respond without perceivable delay, smoothly and with precisely defined force. Motors that drive such high-precision applications therefore have to meet very high expectations.

Saves time and reduces risks

The transport drone is just one of many application examples for which simulation of the drive system during the development phase constitutes a valuable tool. What matters here is not only the behavior of the motor, which can be modeled with reasonable effort based on the data sheet parameters. A complete drive system also requires emulation of the sensor system and control. Realistic emulation of these components helps reduce comprehensive trials with physical drives.

FAULHABER is the first provider of high-quality micromotors to offer the possibility of simulating the application situation realistically at an early stage of development. This is supported by a simulation software that is used by many developers all over the world: Simulink® offers a so-called block diagram environment with graphical interface in which simulations with virtual models are possible without the need for programming. "Various solutions can be tested quickly and easily in an integrated environment. This allows the development concept to be adapted to the actual application at a very early stage," explains applications engineer Marc Lux.

Integrating sensor system and control

He himself created the basis for testing FAULHABER drives using Simulink®.

He compiled a component library in which all brushless DC-motors in the product range are stored together with the matching encoders and Motion Controllers. "A motor consists of an electrical and a mechanical subsystem. The correlations can be described using mathematical equations. In the model, the equations for the subsystems are



interconnected, just like the components when assembling a physical motor."

By modeling typical influences of various sensor systems, it is possible to simulate a realistic speed characteristic. The drive models can also be used by customers to develop their own controllers for actuating brushless FAULHABER motors. Although this is no substitute for tests on physical motors, this model-based method significantly reduces the time and risks associated with development.

For simulation of a controlled drive system with FAULHABER components, the library provides modules for torque, speed and motion control. Motion Controllers of generation 3.0, which include e.g. the models MC 3001, MC 3603 and MC 5005, form the basis. In combination with a motor from the library and a configurable load inertia, the same controller parameters can be determined as those that exist in a physical Motion Controller. By simulating the complete drive system, it is possible to, for example, establish realistic positioning times, adapt the controller parameters or compare the

behavior of the drive when different concepts are applied.

Practical toolbox

To make the simulation easy to use, Marc Lux developed a Matlab toolbox. Matlab is a platform for programming and numeric computing. Scripts created using this platform can be used for simulation with Simulink®. The virtual toolbox contains, among other things, the various drive models, scripts and tables for calculating parameters for the controllers and motors as well as graphical interfaces for intuitively combining the elements required for the simulation.

The Simulink® library has been available online to FAULHABER customers since the beginning of the year. It is intended to supplement existing tools such as the FAULHABER Drive Calculator. It can be used for selecting a drive system as well as for model-based integration into the actual application. Not least, the simulation can also be used for creating a digital twin of the drive and to utilize this twin for advanced features in the context of IoT and Industry 4.0.



www.faulhaber.com/en/motion/

EVEN MORE KNOW-HOW IS WAITING FOR YOU ONLINE!



DriveTime – Expert advice from the drive specialists

In the series of "how to" videos, drive experts from various areas give useful application tips. For example, in just a few minutes users can find out how to design their drive system particularly efficiently, how to connect motors and controllers correctly, how to use the inputs and outputs or which data sheet details are relevant for selecting the right motor/ gearhead combination.



www.faulhaber.com/en/know-how/how-to-videos/



YouTube channel

The video contributions from the how-to video series as well as many other useful clips can be found on the FAULHABER YouTube channel.



www.youtube.com/user/faulhaberEN



Free drive technology webinars

Drive solutions are not usually bought "off the peg", but are instead put together according to the requirements of the application concerned. With its webinars, FAULHABER offers users an easy way of finding out more about drive technology.



www.faulhaber.com/en/know-how/webinar-library/



Ident-no. 000.9122.24

Further information:



faulhaber.com



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



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



[faulhaber.com/linkedin](https://www.linkedin.com/company/faulhaber)



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

FAULHABER motion is also available in digital format:

