



POWER FOR ELECTRIC DRIVE SYSTEMS

Technology and system partner for
electric motors and generators

Feintool's areas of expertise and key technologies

Feintool is your technology and system partner for innovative and economical production processes used to manufacture highly efficient components for electric motors and generators. We manufacture motor and generator cores (rotors and stators) for battery electric (BEV) and hybrid (HEV) vehicles, industrial applications, and renewable energy sources.

The entire process chain from a single source

- ▶ Development, engineering, project management
- ▶ Technical design (calculation, construction, etc.)
- ▶ Prototyping and pilot production
- ▶ Tool, mold, and jig making
- ▶ High-volume parts production

Feintool's process portfolio

- ▶ Rotor and stator manufacturing
- ▶ Stamping, casting, and laser cutting
- ▶ All stacking technologies
- ▶ Patented *glulock*[®] adhesive stacking process
- ▶ Aluminum, aluminum alloy, and copper die-casting

Further processing

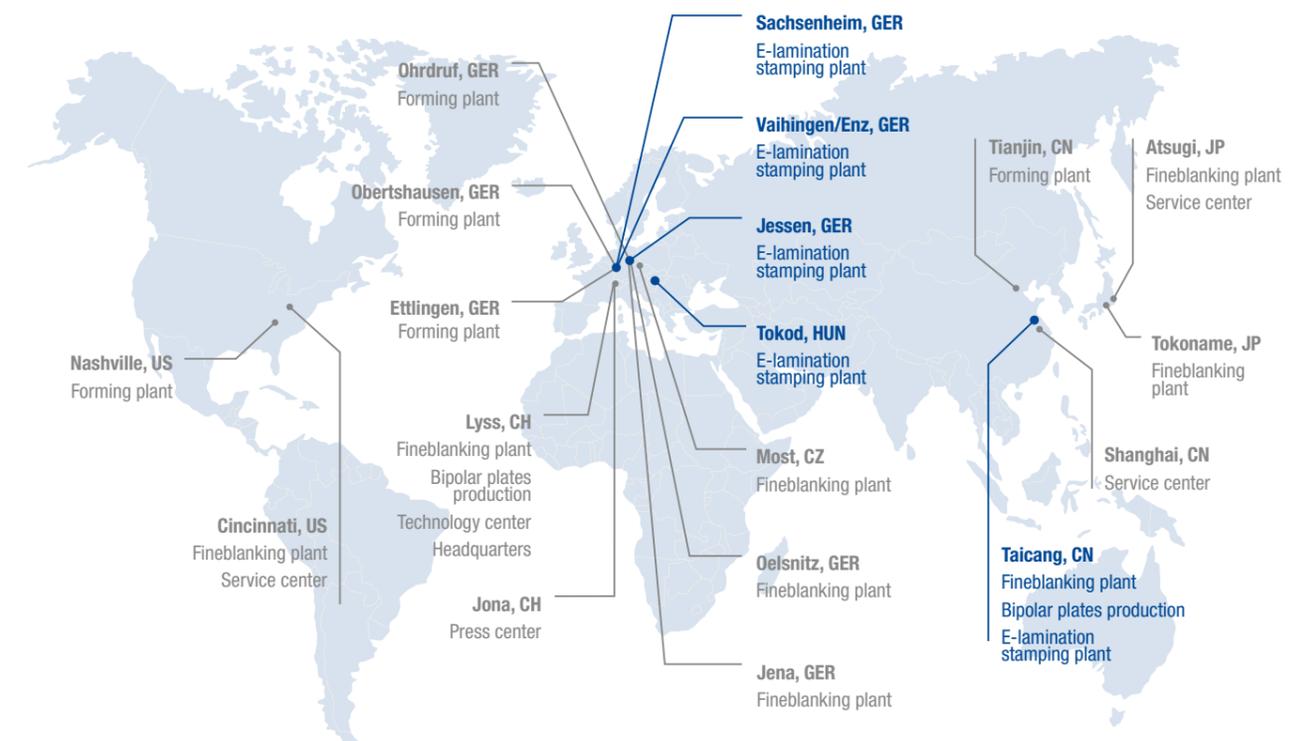
- ▶ Rotor machining
- ▶ Joining processes: shafts, magnets
- ▶ Insulation: plastic overmolding, paper insertion, coatings
- ▶ Automated testing and packaging

You have the challenge, we have the solution – don't hesitate to get in touch with us!

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GLOBAL EXPERTISE, LOCAL PRESENCE

Feintool is the world's leading supplier in the field of fineblanking, forming, and rotor and stator manufacturing. Headquartered in Switzerland, the company operates its own production facilities and technology centers in Europe, Asia, and North America. Our 3 500 employees and 100 vocational trainees around the globe are hard at work on new solutions to provide you, the customer, with clear advantages in your market. You benefit from a powerful global network with a local presence in the world's most important economic regions. Our customers appreciate our many years of experience, our high level of innovative capacity, our solution-driven approach, and our service mentality.





ELECTRIC MOBILITY

Feintool is driving electric mobility forward

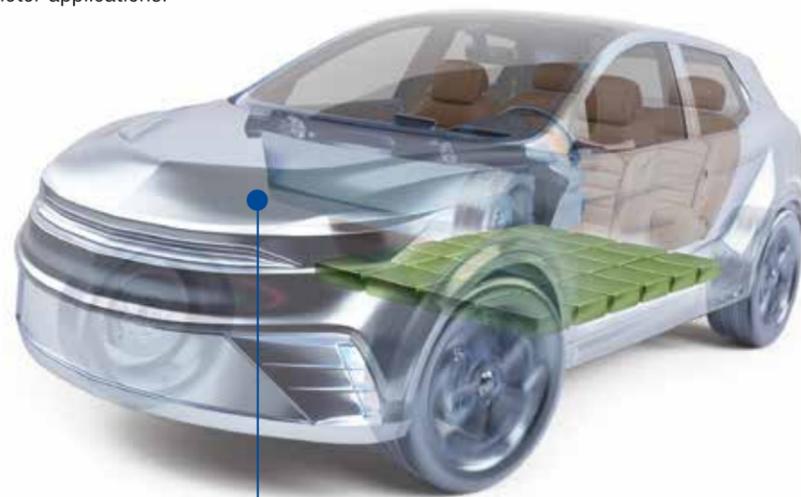
Technology leader with the greatest efficiency

In the field of electric mobility, we manufacture rotors and stators for the main drive of all-electric vehicles and the auxiliary drive of vehicles with hybrid drive systems. We pride ourselves on being the technology leader in this field, as our decades of experience have enabled us to systematically produce efficient motor cores with maximum efficiencies using all standard stacking processes and with a technology-agnostic approach. Full traceability, documented processes, and precise production sequences are the norm at Feintool.

Our electric motor components with different levels of scale are used in vehicles for demanding electric motor applications.

The automotive industry trusts Feintool

As a supplier to OEMs and Tier 1 suppliers of main and auxiliary units, we meet the requirements of the international automotive industry's quality management systems: all plants are ISO 9001 and VDA certified, and in addition, we hold the IATF 16949 certification. Through integrated feature inspection and process monitoring, we systematically implement customer and standard requirements.



ASM motor for all-electric vehicles – die-cast aluminum rotor stator glued with *glulock* HT

FSM motor for plug-in hybrid and all-electric vehicles – rotor glued with *glulock*® stator with hybrid bonding technology



INDUSTRY

Diverse applications for numerous industrial sectors

An extensive product portfolio with a high level of vertical integration

With both traditional IEC motors and the highly efficient and energy-saving KSPM motors developed in-house, Feintool offers a complete portfolio of electric motors ranging from small to very large sizes with a high degree of vertical integration for a variety of industries. We closely follow megatrends such as digitalization, organization, and sustainability to achieve the greatest possible degree of efficiency and application precision for our customers.

Off the shelf as well as tailor-made for the customer

Thanks to our global presence and decades of experience, we offer an extensive product portfolio. In this context, we rely on standardized series such as the modular IEC or KSPM systems, but also provide expert advice and produce in a flexible manner according to your individual needs. When it comes to electric motors/generators, our focus is always on achieving maximum efficiency at competitive costs.



Industrial products suitable for a variety of applications worldwide

Thanks to their versatility and efficiency, electric motors/generators are used in various industries, sectors, and applications worldwide.

- ▶ In facilities where the energy supply is critical to operations (data centers, hospitals, etc.), in uninterruptible power supply (UPS) generators, and as pumps and fans in water supply and air-conditioning systems

- ▶ Heat pumps, heating pumps, air conditioning pumps and fans
- ▶ Drive systems for towing vehicles, industrial trucks, etc.
- ▶ Water pump motors used at large, international water parks
- ▶ Electric motors for household appliances
- ▶ Roller shutter motors
- ▶ Electric hand tools, construction machinery
- ▶ Medical technology



Large sheet metal applications

T-segments (glued or interlocking)

KSPM rotors



RENEWABLE ENERGY SOURCES

Wind and hydropower are the future

Maximum quality on a large scale

Just as with electric motors, rotors and stators form the core components of generators for wind turbines and hydroelectric power plants. Although these power generation components are of considerable size, the manufacturing tolerances for the components are low – even when it comes to large-diameter layered sheets (cookies or segments), Feintool maintains the same high degree of precision and standards as it does for electric motor cores for electric mobility.

Flexible scalability and numerous designs

Feintool produces rotor-stator stacks for wind turbines of all sizes and power classes used worldwide for both onshore and offshore installations. Our range of services extends from prototyping to pre-series with near serial tolerancing and high volume. Depending on the planned application, we build ASM (externally excited asynchronous machine) and PSM (permanently excited synchronous machine) cores.

In addition to electrolamination applications for direct energy generation by means of generators, Feintool's products are also used indirectly in the generation of renewable energy as pumps for the production of biogas in the agricultural industry.

We offer a broad portfolio of additional downstream processes in the field of renewable energies.



Our experience is the key to creating such added value

Thanks to our global presence, worldwide business partners, and decades of experience, we offer an extensive product portfolio. As a result, our customer service is extremely comprehensive and we are able to respond in a flexible and situation-specific manner to your needs.



Rotor stack on a shaft



Stator for an onshore wind turbine



INNOVATION AND DEVELOPMENT

High standards for maximum quality

Innovation and development lead the way

Thanks to its close proximity to customers, Feintool has its finger on the pulse of the automotive, industrial, and renewable energy markets across all sectors and is familiar with individual requirements and needs in terms of technology and products. With our innovative and one-of-a-kind GeoDrill, GeoShift®, and *glulock*® processes in the area of interlocking and lamination stacking, we are the market leader when it comes to precision and quality.

Research and development

Our in-house R&D Department follows a defined strategy, focusing on the further development of proven bonding technologies with regard to application processes and adhesive chemistry, as well as conducting research into innovative, alternative baking processes. The aim is to improve product properties such as increasing temperature resistance, increasing stability and ruggedness, and to ensure that lamination stacks are completely sealed. In addition to maximizing the

performance of the electric motors, development activities also focus on aspects such as cost efficiency and sustainability.

Collaboration with industry specialists

As a catalyst on the road to the lamination stack of the future, we collaborate with universities, research institutes, and various suppliers. This gives us access to extensive expertise that we can use when designing and running simulations of your electric motors. In addition, we are happy to provide you with information on current trends and developments.

Rapid prototyping for flexible customer requirements

The ability to produce prototypes from a process that closely resembles full-scale production with little lead time allows us to respond with flexibility to customer requirements at a very early stage in a project and to develop lamination stacks in line with individual requirements. In doing so, we follow a structured project management approach and offer personalized guidance with regard to costs and benefits.



glulock MD bonding technology/working principle



PROTOTYPING, TOOL AND MOLD MANUFACTURING

Flexibility for our customers is our top priority

Your partner from A to Z

Our range of services include, technical consulting, feasibility analysis and support from the first development steps and samples to pilot production. The choice of manufacturing process depends on your specific requirements and order volume, with the cost-effectiveness of your production process being our top priority.

Rapid prototyping: the key to success

Prototypes are needed to test customers' innovative ideas in a real-world environment – the faster and more cost-effective, the better. The ability to produce prototypes from a process that closely resembles full-scale production with little lead time allows us to respond with flexibility to customer require-

ments at a very early stage in the project and to develop lamination stacks in line with individual requirements. In doing so, we follow a structured project management approach and offer personalized guidance with regard to costs and benefits.

Manufacturing processes for low-volume and preproduction runs in prototype construction

- ▶ Solid-state laser cutting
- ▶ Dual-head laser cutting
- ▶ Close-to-production stamping for all variants of lamination stacks using universal tools
- ▶ Partially automated lamination stacking
- ▶ Casting and baking process
- ▶ Laser welding and weld testing

An unmatched level of experience and expertise

We manufacture and service stamping tools, die-casting molds and matching jigs at our in-house tool and mold shop. This is how we minimize tolerances and achieve the best quality. We manufacture tools with dimensions of up to 2 000 × 1 500 mm.

The trend towards greater power density, compactness, and lightness is making components ever more sophisticated. Thanks to many years of expertise and state-of-the-art technical equipment, we are able to meet even the most unusual requirements when it comes to shape. We build soft tools for preliminary stamped sheets and multistage tools that are then used for the largest production volumes with the highest precision requirements. The multistage tools cut in an integrated machining process, meaning even sophisticated components can be manufactured cost-effectively directly out of the tool.

For testing and sampling of the stamping tools, we use a specific press specially designed for this purpose.

Feintool tooling expertise

- ▶ Pilot production tools and soft tools
- ▶ Progressive cutting tools
- ▶ Interlocking tools
- ▶ Single notching tools
- ▶ Baking, gluing, and welding fixtures
- ▶ Tool spare parts and wear parts
- ▶ Tool production up to 2 000 × 1 500 mm
- ▶ Test stamping press
- ▶ Die-casting mold production

Progressive carbide and steel dies



Wire EDM



Aluminum die-casting



Tool making



TECHNOLOGIES

Electrolamination machining

Slitting



Single notching



Stamping



Laser cutting



Production

Whether for micromotors, drives for electric vehicles, or power plant gensets, Feintool's electrolaminations are built for maximum performance. In the field of rotor production, we are already a system supplier. The electrolaminations meet the highest standards of quality and combine a variety of outstanding properties.

- ▶ Rugged and lightweight
- ▶ Outstanding electromechanical properties
- ▶ Minimal manufacturing tolerances

Production techniques

We select the ideal production method for each customer's specific needs and use the most suitable raw material.

- ▶ Slitting the raw material for efficient use
- ▶ Stamping in follow-die cutting on high-speed blanking presses with table lengths of up to 3.7 m and diameters of up to 600 mm
- ▶ Cookie cuts, segments, single poles, rod cores, and linear stacks
- ▶ Laser cutting
- ▶ Single notching
- ▶ Interlocking, stapling, riveting, baking, gluing (*glulock*[®], *glulock* HT, *glulock* MD), or laser welding of sheet stacks
- ▶ Coating of sheet stacks
- ▶ Aluminum, aluminum alloy, and copper die-casting for rotors with diameters of 15 to 600 mm and stack lengths from 7.5 to 640 mm
- ▶ Insertion gluing and gluing on rotor magnets
- ▶ Plastic overmolding
- ▶ Shaft joining

The right process for every output

We use the most suitable and cost-effective manufacturing process for each output scenario.

- ▶ Laser-cut sheets for prototypes
- ▶ Combination products made by laser cutting and stamping
- ▶ High-volume production of stamped sheets and stacks

Laser cutting

As the output of components decreases and their variety increases, laser-based production technologies are ideal for producing prototypes or small to medium quantities quickly and cost-effectively in a tool-free process. The solid-state and dual-head laser systems machine electrolaminations with thicknesses from 0.1 to 1.0 mm with an accuracy of a few hundredths of a millimeter.

Stamping

At Feintool, we stamp sheets of any shape and size for large quantities in follow-die cutting, manufacture with single notches, and stack almost any desired length of iron. The high-speed blanking presses have a stamping force of 25 to 1 000 t, and with roughly 10 000 differently shaped individual notching punches, even unusual customer requirements can be produced cost-effectively and with flexibility.

TECHNOLOGIES

Stacking

Motor efficiency and performance not only play a critical role in the field of electric mobility, but also in every type of electric motor application. These include, in particular, such factors as energy efficiency, stability of the stacks, as well as their seal with respect to the cooling liquid. Choosing the ideal stacking process for each application is critical.

- ▶ In-tool lamination core stacking
- ▶ Interlocking
- ▶ Riveting
- ▶ Baking with bonding varnish
- ▶ Annealing
- ▶ TIG and MIG welding
- ▶ Laser welding
- ▶ Gluing (*glulock*[®], *glulock* HT, *glulock* MD)

In-tool lamination core stacking

When it comes to finished in-tool lamination core stacking for rotors and stators, we can offer any desired stud contour. Spiral skewing allows both twisting (GeoDrall) and sheet thickness compensation (GeoShift[®]) in the stack.

glulock[®] – the innovative adhesive stacking process

By means of our patented *glulock*[®] technology, rotor and stator laminations can already be joined during the punching operation by means of adhesive dots. The production-proven adhesive stacking method is extremely precise and eliminates the need for electrically disturbing fastening elements, thus reducing eddy currents and minimizing magnetic resistance. The result is a much more efficient stack with fewer electrical losses, which has a particularly positive effect in high frequency ranges.

Compared to conventional stacking methods, *glulock*[®] proves to be inexpensive, highly precise in its implementation, and offers significant improvements in stacking tolerances in terms of parallelism, shape accuracy, concentricity, and length tolerance. In addition, the output power increases and the motor size decreases. Even thin sheets (0.1 mm) can be stacked using *glulock*[®].

glulock HT (High Temperature) improves strength and media resistance and enables increased temperature resistance up to 180°C. It can be used, for example, in ATF oil within temperature class H.

glulock MD can be used to achieve an almost full-surface bond by means of several adhesive dots on the sheet metal, thus enabling us to meet the required tightness requirements. Gluing on the yoke and tooth ensures stability.

Interlocking



Aluminum die-casting



Copper die-casting



Plastic overmolding



TECHNOLOGIES

Further processing

Aluminum die-casting



Die-casting

We manufacture rotors for asynchronous motors in pure aluminum, aluminum alloy, and copper die-casting. You can configure your machine from the wide range of shape and length options available in our online catalog.

Decades of experience in the simulation and design of die-casting rotors, in the construction of molds, and in production guarantee our customers the best casting quality. This is ensured by testing during high-volume production, which ranges from standardized random sample testing to 100% inspection (depending on customer requirements). In the process, we use state-of-the-art sensor technology to assess the rotor bars and X-ray technology/computer tomography to inspect the short-circuit rings. The result is a product that is unparalleled on the market in terms of its efficiency, speed stability, engine performance, and quality.

Laser welding



Baking

In addition to the stacking processes of in-tool lamination core stacking and gluing using *glulock*[®], Feintool also offers state-of-the-art solutions in the field of baking sheet metal stacks. Our portfolio includes hot-air systems, systems using heated pressure pads, and inductive processes. We use all the common types of bonding varnish in the grades and coatings available on the market. In the interests of energy and process cost efficiency, we have developed an in-line baking process as an alternative baking concept. This process, which is integrated into the punching operation, makes it possible to produce dimensionally stable stacks within a short cycle time.

Baking



Metal and plastic joining

Injection-molded slot insulators made of plastic are a worthwhile alternative to conventional paper insulators for electric motor components. By means of stamping and injection molding in perfectly coordinated processes, we produce windable components of consistently high quality.

Metal and plastic joining



PRODUCTS

Motors for maximum levels of efficiency

IEC electric motor energy efficiency classes

The IEC (International Electrotechnical Commission) standards define, among other things, energy efficiency classes for electric motors.

- ▶ IE1: Standard Efficiency
- ▶ IE2: High Efficiency
- ▶ IE3: Premium Efficiency
- ▶ IE4: Super Premium Efficiency

We are equipped to handle future adaptations and extensions of the standards.

Feintool's modular IEC system

Using our online catalog, you can configure a wide range of electric motors, electric motor components, and additional products for machines, calculate their efficiency, and then order them directly.

Feintool's IEC motors meet at least the IE3 standard, which means they are extremely energy efficient.

IEC

Size/view	Number of poles			
	2	4	6	8
IEC 056	x	x	x	x
IEC 063	x	x	x	x
IEC 071	x	x	x	x
IEC 080	x	x	x	x
IEC 090	x	x	x	x
IEC 100	x	x	x	x
IEC 112	x	x	x	x
IEC 132	x	x	x	x
IEC 160	x	x	x	
IEC 180		x	x	
IEC 200	x	x	x	x
IEC 225	x	x	x	x
IEC 250	x	x	x	x
IEC 280	x	x	x	x
IEC 315	x	x	x	x
IEC 355	x	x	x	x

Order directly from our online store:



KSPM MOTORS

Synchronous motors with maximum efficiency



Modular energy savers

KSPM motors (permanent magnet synchronous motors) are the energy savers among electric motors. They comply with the international IEC 60034-30-1 standard, which uniformly governs the requirements for energy-efficient electric motors worldwide. The KSPM series is ideally suited for efficiency class IE4 (Super Premium Efficiency).

The KSPM product family represents the systematic further development of the tried-and-true IEC series. It is based on their standard sizes and is designed for permanent magnet synchronous motors with axle lengths from 63 to 250 mm. A set always consists of the stator and the corresponding number of rotor modules. The rotor modules for axle lengths from 80 to 250 mm have a standard iron length of 30 and 40 mm. The modules for axle lengths from 63 to 71 mm have a standard iron length of 20 and 30 mm.

The KSPM series has a modular design. As a result of this modular design, we are able to cover a wide range of customer requirements and areas of application with different combinations of modules. Another advantage of this flexible series is the short delivery time of KSPM products.

Maximum efficiency and flexibility

KSPM motors excel especially in industrial applications. They stand out due to their high efficiency and extremely low cogging torques. They are also ideal for field weakening, which improves the usability of converters. In addition, KSPM motors can be operated without sensors, which enables their use in, for example, EX motors with power supplied via converter.

In addition to the extensive range of modules for various sizes and efficiencies, we offer technological equipment and expertise in further processing.

For the KSPM 63/4 to KSPM 132/6 series, an automated system is available for inserting and gluing magnets into the rotor stacks. In this case, the magnets are reliably glued in using a two-magnet magazine slot system that processes neodymium-iron-boron (NdFeB) magnets.

Thanks to short delivery times, you will quickly receive the Feintool motor that is perfect for your application.

KSPM series

Examples for IE4 (IE5). Other efficiency classes and speeds available on request.

Size/view	Number of poles	Power [W]	Rotational speed [rpm]	Iron length [mm]	Efficiency [%]	Iron losses [W]	Copper losses [W]
63/4,50	4	180	1 500	40	82.5	6	26
71/4,62	4	370	1 500	50	86.8	12	38
80/4,70	4	750	1 500	70	88.3	22	69
90/4,836	4	1 500	1 500	80	88.4	35	145
100/4,936	4	3 000	1 500	110	89.8	63	262
112/6,115	6	4 000	1 500	120	91.5	102	240
132/6,135	6	7 500	1 500	150	93.0	180	345
160/6,165	6	15 000	1 500	180	93.7	338	574
180/8,190	8	22 000	1 500	190	95.0	443	606
200/8,215	8	30 000	1 500	210	95.6	475	753
225/8,240	8	45 000	1 500	240	96.2	813	768
250/8,270	8	55 000	1 500	240	96.6	800	740
280/8,305	8	90 000	1 500	300	97.0	1 200	1 030
315/8,375	8	160 000	1 500	340	97.4	2 030	1 420



Customer-specific solutions

Thanks to our many years of expertise in the construction of motors, the precise design of electrical motors together with our strategic partners, FMEA risk analysis, prototyping by means of laser cutting and test stamping presses, as well as the application of the latest manufacturing technologies, including value and feature-enhancing further processing, we

are able to supply you with perfectly customized electric motor or generator cores for any application at cost-effective terms.

You have the challenge, we have the solution – don't hesitate to get in touch with us! feintool-pses@feintool.com

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