RAIL.

ROAD.

SERVICE.

Electric motors, alternators, gearboxes and traction drives
for rail rolling stock and commercial road vehicles.

TRAKTIONSSYSTEME AUSTRIA

RAIL.ROAD.SERVICE.

The future is electric mobility. Innovative traction drives by TSA.

Traktionssysteme Austria is a company with an ambitious goal: With our expertise and our wide product range, we guarantee the best individual solutions for our customers. We are your experienced partner for all questions related to asynchronous and permanent magnet drives. As a full-range supplier, we have the right solution for your individual requirements. Ranging from first design drafts and delivery to aftersales services.

We offer a one-stop solution and guide you every step of the way through development and engineering, manufacturing and inspection as well as customer services for the entire product lifetime of our traction motors, gearboxes, alternators and drives. Our products help you saving time and money because we optimize the ease of maintenance and life cycle costs.

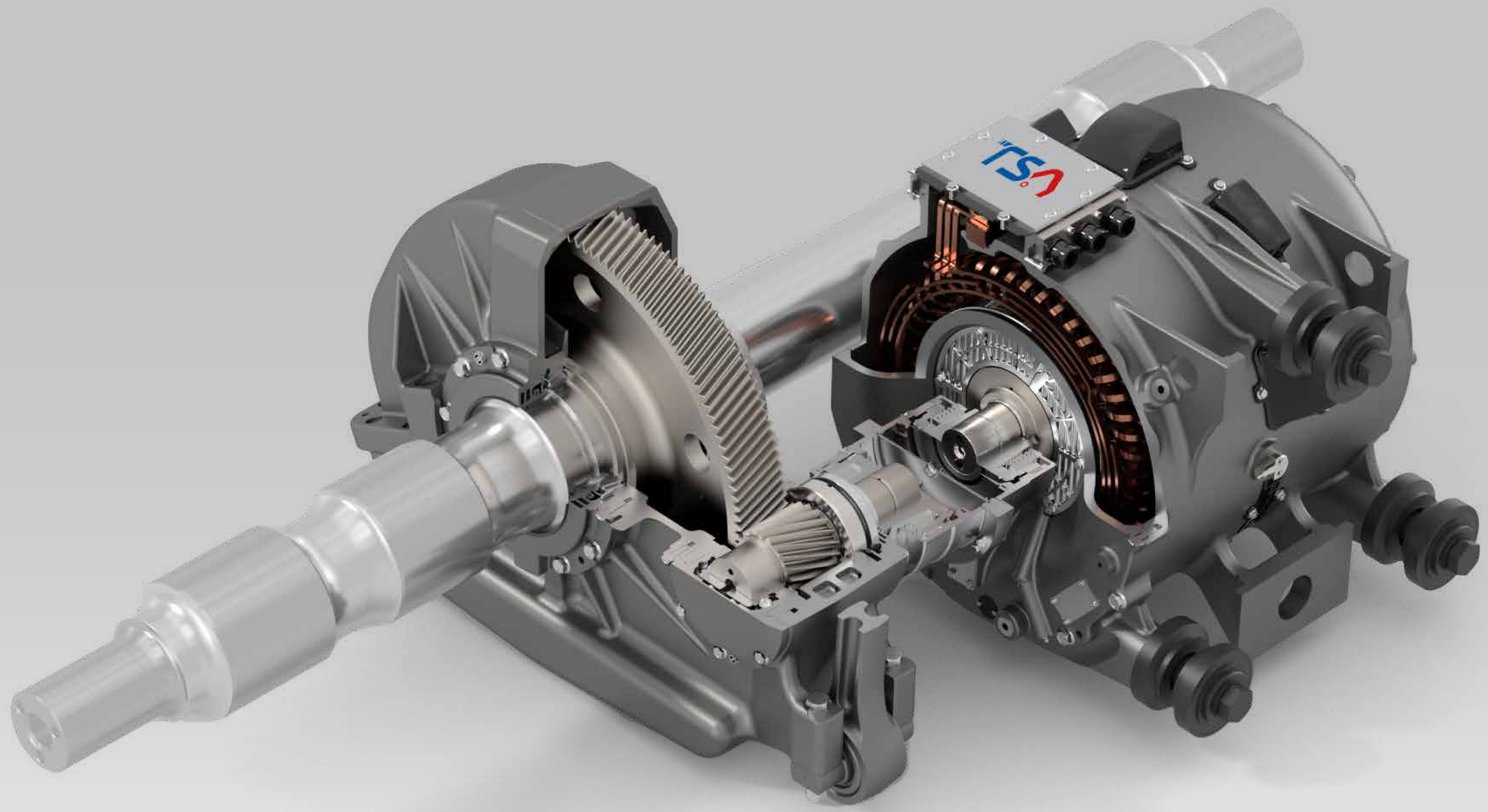
TSA provides solutions to both electrical and mechanical engineering challenges. Additionally, we offer all mechanical interfaces between traction drive, bogie and body as well as sophisticated technical support.

Benefits of TSA Traction Drives

- Flexibility: Our products are tailor-made to perfectly meet your requirements
- High power and torque density, resulting in weight savings and minimum space
- TSADUR® class 220 insulation system, offering electrical, mechanical and thermal reliability
- International know-how regarding standards and certificates (RDSO, GOST, RGS Railway Group Standards, Deutsche Bahn Quality Check)
- Compliance with requirements of Standard Group 60349
- Copper squirrel-cage design, leading to higher efficiency and lower rotor temperatures
- Traction motors electromagnetically optimized for converter operation
- Innovative cooling concepts available to meet specific application requirements
- Low-vibration and shock-resistant structural design
- Use of insulated bearings and/or grounding brushes to integrate with vehicle design to avoid converter-induced bearing currents
- Products designed for a lifetime

Why choose a TSA Traction Drive for your vehicle?

Because we consider the entire vehicle and its complete electric drive system, not only the individual components.



TSA Engineering

The in-house engineering and the vicinity of design department, production and test field are two of the core strengths of TSA.

State-of-the-art tools are used to develop our drives, motors and gearboxes as well as generators:

Space is commonly limited in traction applications, so available space becomes an important consideration during vehicle propulsion design. The required size of any electric motor is mainly defined by the required torque and less so by power.

- Electromagnetic, structural and thermal Finite-Element Analysis (FEA)
- Computational Fluid Dynamics (CFD)
- Thermal network analysis, allowing for simulation of drive cycles
- Simultation of converter-included harmonic losses
- Rapid prototyping, pre-testing with 3D-printed parts

We are your partner for an optimized drive system because we know motors and gearboxes.

Common rulebook and design priniples apply to our entire mtor and gearbox designs. We use standardized catalogue parts and consumables for motors and gearboxes, resulting in lower warehousing effort of spares inventory and minimized risk of non-availability.

Unified documentation (operation and maintenance instructions) for motor and gearbox, well aligned maintenance intervals and special tools is something we do as a matter of course.

Customer training sessions for motor and gearbox together result in less training and coordination effort.

On the right track

Wide-ranging requirements, one single provider for your solutions.

TSA's electric drives are tailored to the specific requirements of your rail vehicles, starting from the offer through to our Long-Life Value Service, from the initial design drawings through to final delivery. The focus is always on our customers' desire for a comprehensive solution, based on electrical and mechanical criteria.

Why choose TSA as your supplier for your rolling stock?

Because you will find no other company whose products fit your rail vehicles perfectly like ours do.

The challenges of cutting-edge electromobility in the rail car market are huge. At the same time, vehicle manufacturers and component suppliers have less and less room to maneuver. It is necessary to constantly optimize the performance, durability, size and weight of the propulsion systems, without affecting price and availability. Traktionssysteme Austria is rising to these challenges.

Operators and manufacturers of rail cars don't need isolated innovative leaps. What they need is a consistent technological advantage.

Benefits of choosing TSA as the full-range supplier for your rail vehicles

- Over 60 years of experience in design and delivery of electrical rotating equipment for railway applications.
- Traktionssysteme Austria is an independent supplier of traction motors and gearbox combinations, forming the highest quality drive systems. With our vast system integration expertise, TSA has become the preferred partner for both new-build and traction upgrade programs.
- We support the business success of our customers with agility and quick decision-making by thinking holistically and acting promptly.
- Technology leadership and best in-class engineering guarantee that rolling stock producers and railway operators benefit from lowest possible operating costs, minimum downtime and maximized revenues.
- Custom after-care solutions are ensured by a global aftersales and service network.

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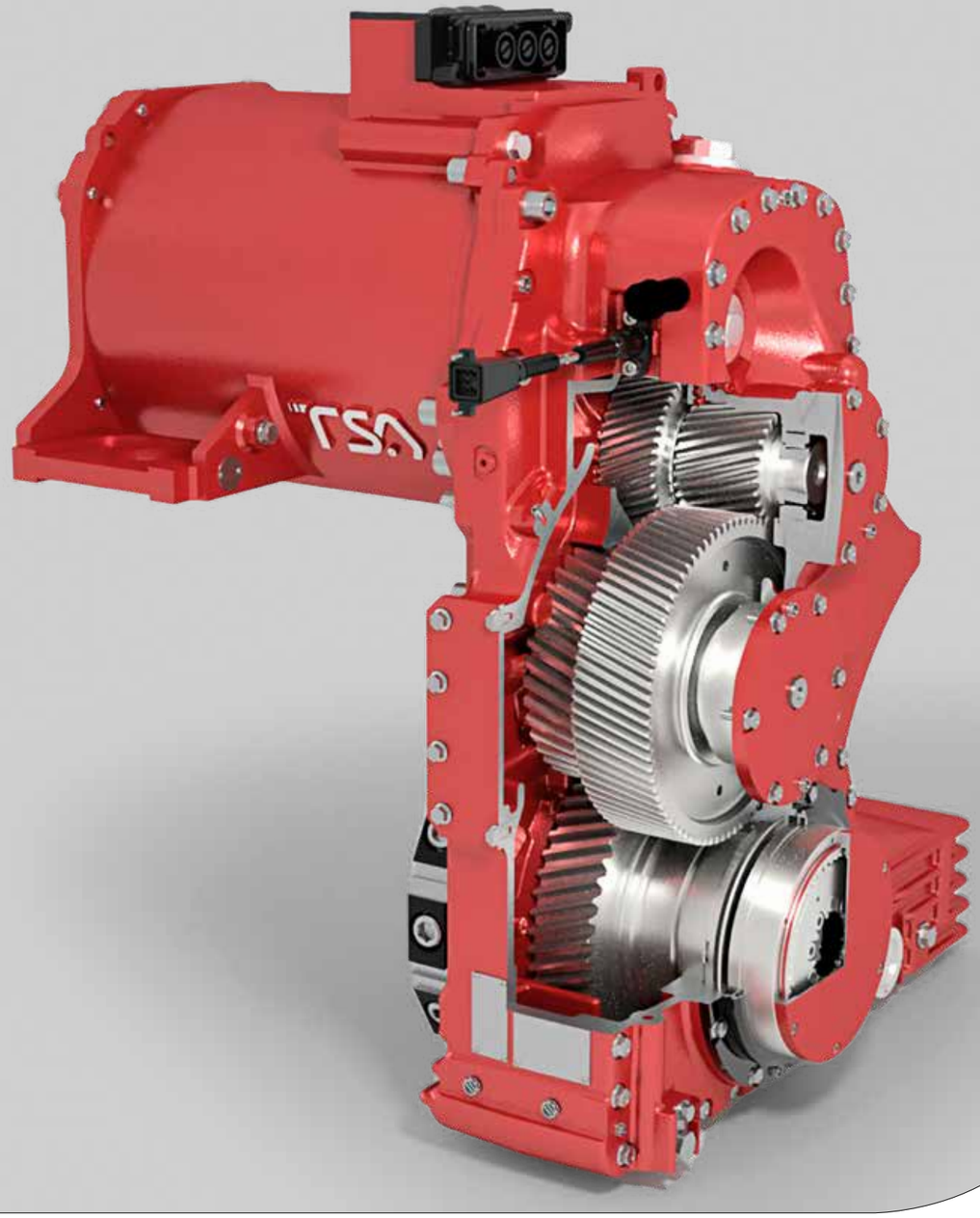

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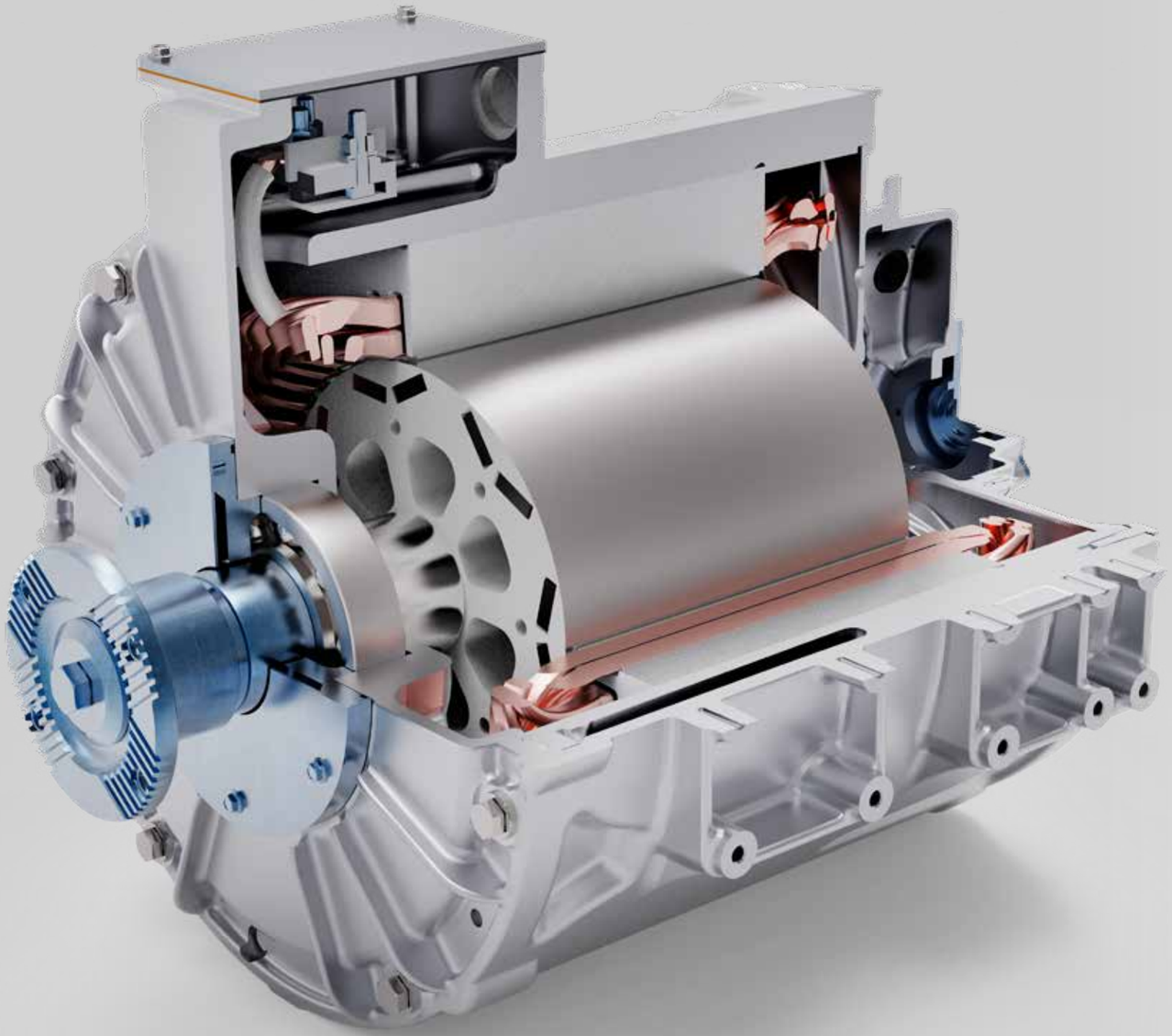

Get on the road with us

TSA bus motors operate in road commercial vehicles all over the world.

From Germany to Mexico, you will find our bus motors in road vehicles around the world. Our motors operate in all climate conditions. Since 2000, TSA motors have been powering electric buses by Solaris, Van Hool and Hess. Also VDL and Bozankaya are among our e-bus industry partners.

Why choose TSA as a supplier for your road vehicles?

Because electric mobility is our business.

Our years of experience allow us to guarantee the best solutions. As a manufacturer of electromechanical components for rolling stock and road transport vehicles, we know how electric mobility works. We also know what it means to be part of the electric drive system. Teaming up with external partners and using our experience skillfully to integrate our solutions into all essential interfaces is what we know best.

Our electric bus motors are optimized with regard to efficiency, performance and installation space in order to ensure the greatest possible range for our customers and passengers. As a technology leader, we are the ideal partner for operators and manufacturers of electric buses worldwide.

The future drives electric, with TSA.
Innovative solutions for urban electric mobility around the world.

Benefits of choosing TSA as your supplier for the bus motors you need

- Proven concept with TSA's experience of more than 2,600 motors on the road.
- Our bus motors are designed exactly according to your requirements by taking into account available space, common operating scenarios, cooling concepts, voltage and current.
- Go cost-efficient with TSA.
- A simple electrification of existing vehicle models is possible without major changes to the chassis, axles, statics or differential.
- Rugged design with hardly any maintenance needed.
- Easy exchange of the motor with constant availability of the vehicle.
- The simple mechanical and electrical traction systems promise the highest resale value of your bus.

Welcome on board

Off the road – Ground Support Vehicles with TSA Motors (GSE).

The big challenge in the ground support equipment area is to adapt the motor to the inverter. Only through an efficient interaction of both components can the motor achieve its maximum energy efficiency. Thanks to our many years of experience in the rail sector, we can offer the best possible holistic solutions regarding motors and inverters. Another advantage when choosing TSA as your supplier is that we willingly work with prototypes, low and high volume needs as well as special orders.

The future of airports is electric, with Traktionssysteme Austria. We develop what you need for your ground support vehicles.

Benefits of choosing TSA as your supplier for your GSE motors

- More than 56,000 TSA motors are powering electric vehicles around the world.
- Our solutions are the most flexible ones in the market.
- You did not find the right motor among our products? No problem – we will develop it for you!
- We work together with high-quality partners in the area of inverters.
- You will not find a better partner or supplier. We are happy to guide you through all the steps in finding the best solution for your GSE vehicles.
- In addition to our products, we also offer customizable service programs.

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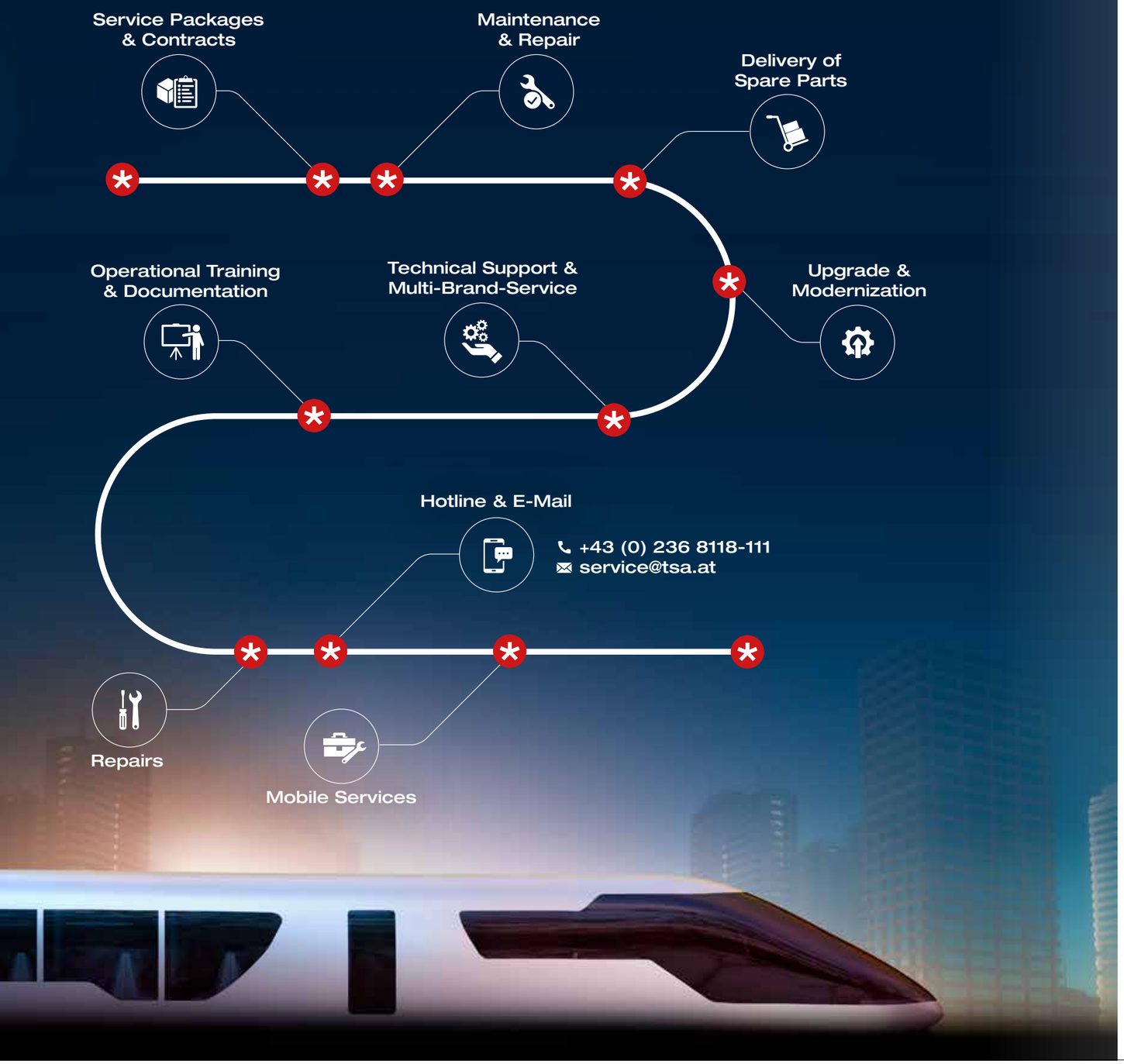

Best service for guaranteed value. For the lifetime of your vehicle.

Today's mobility is changing at rapid speed. At TSA, to keep mobility in service, we believe that value retention is more important than ever. Therefore, our understanding of comprehensive service for the entire product lifetime comprises of smart maintenance and service concepts. This includes spare parts management, guaranteed lead times, comprehensive diagnosis reports on the technical condition of the motor, gearbox or component and innovative upgrades. At TSA, we call this Long-Life Value Service.

The three TSA service pillars

Service at TSA comprises of more than just maintenance and repair. We have made it our business to satisfy our customers by providing exceptional services. Benefit from our three service pillars!

1. Availability of exchange motors and gearboxes
2. Comprehensive functional and performance testing
3. Original manufacturer warranty

One contact, numerous advantages

- Preventive maintenance and service offers mitigate risks and ensure better availability.
- Individual and customizable packages for your requirements and needs. The costs are exactly calculable for you.
- Personal and individual services worldwide.
- TSA is your only contact. We know our customers and can therefore offer you the solutions that will help maintain the value of your vehicle.
- Long operational life of your vehicles.
- Maximum protection against breakdowns through preventive maintenance.
- Long operation intervals and minimum downtime reduced only to scheduled maintenance activities.

We know which technologies are at the edge of technology today and which requirements have to be considered tomorrow. As one of the top manufacturers of traction systems, we can evaluate the entire drive unit comprising motor and gearbox with a holistic approach.

The result is always quality and technical leadership in the rail vehicles and buses of this world. With our Long-Life Value Service, we offer you and your vehicles value retention and with our many years of expertise, we also ensure that you are ready to meet tomorrow's challenges. This is our promise to you.

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PITSTOP
TRAKTIONSSYSTEME AUSTRIA

Every motor is only as good as the sum of its individual parts. Avoid unexpected failures and ensure the long-term value retention of your vehicle.

Service agreements facilitate the planning and control of safe operation and effective maintenance. All contracts and packages are tailored to your individual needs and requirements, ensuring the reliable performance of your vehicle at all times.

PitStop is a service that we set up with potential customers for even more specific requirements. It is a program, tailored to the particular case of the customer, with the aim of enabling the shortest possible turnaround time. Our main objective is to process all workpieces without delay in order to exclude downtimes. We provide selected packages which include a number of motors as exchange floats to reach the ideal workflow effectiveness. Our easy-care flat rate includes an overall service for each motor, gearbox or drive, regardless of its condition or potential defects.

Through many years of engineering experience and continuous R&D, we ensure that you always receive the best technical solution for your requirement. This means that we do not simply replace or repair components, we always offer you the most up-to-date solution. Condition assessment checks allow us to evaluate if our motor can be serviced or if it has to be replaced. This applies to our own products, but also to products from other manufacturers (multi-brand service). When servicing our own motors, we also offer an additional warranty.

As an OEM in the railway industry, we also hold an ECM Certificate (Entity in Charge of Maintenance) which by means of a quality maintenance system ensures that the rail vehicles we are in charge of are in a safe state of running.

We have more than 60 years of experience with one exclusive focus regarding our products, what gives us the leadership in technology. As the top manufacturer of electromechanical drives for railway rolling stock and commercial road vehicles, **we know our job best.**

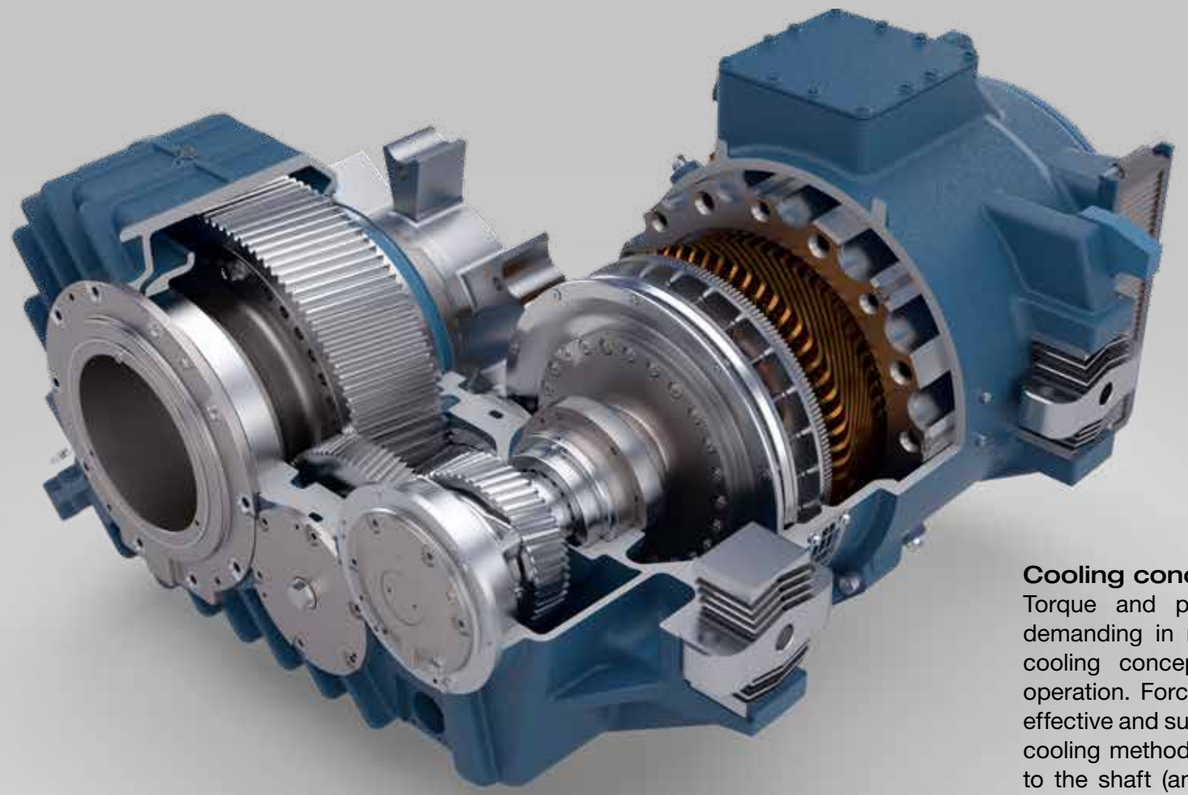
1 BACK FOR CHECK

2 SERVICE & REPAIR

3 RETURN FOR OPERATION

ECM certified
VO (EU) 2019/779

Electric Machine Concepts



How to choose the suitable traction motor?

Three-phase motors have been state-of-the-art in traction applications since the evolution of power electronics. The key benefits of their use are the high power density, efficiency and reliability. The induction motor (asynchronous motor) is the most widely used motor type today. Alternatively, permanent magnet synchronous motors have become an increasingly popular solution because of their high efficiency under specific operating conditions.

Basic aspects for selecting a traction motor

Available space

Space is commonly limited in traction applications, so the size of the machine is of extreme importance for the vehicle propulsion design. The dimensions of the electric motor are mainly defined by the required torque (and not primarily by power), whereas the available space is defined by the car builder or systems integrator.

Common operating scenarios

Torque and power values quoted in the motor data sheet represent single operating points. Often, they do not show the thermal impacts directly, so time limitations have to be assessed separately in order to compare different motors and to prevent motors from overheating. Operating points marked with operating mode “S1” (often called the nominal or rated point as well) can be driven continuously if the specified cooling is ensured.

Typically, our motors are designed according to the specific operation regime of the particular vehicle. You send us operational data such as duty cycles and runtime simulations and we calculate the energy consumption and the motor temperatures. Based on this data, we can exactly tell whether the selected motor is suitable for the routes you want to travel.

Cooling concept

Torque and power density requirements are extremely demanding in modern traction motors, therefore a proper cooling concept is crucial to avoid overheating during operation. Forced air ventilation with an external fan – very effective and suitable for all motor sizes – is the most common cooling method. Self-ventilation with a fan, directly attached to the shaft (and therefore without the need of an external cooling system), is also frequently used, either with an open or an encapsulated machine design. In certain applications, liquid cooling is applied, featuring a very low noise level.

Voltage and current

The voltage level of the motor can be adapted by changing the electrical winding accordingly, so at the concept stage of a new propulsion design the voltage level is of minor importance. However, knowing the motor voltage is helpful for calculating the current values which have a considerable impact on the converter design.

Induction machines (IM) / Asynchronous machines (ASM)

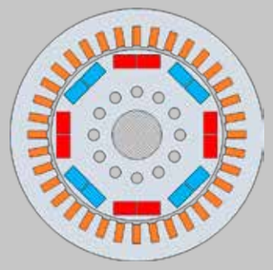
Induction machines (asynchronous machines) with a short-circuit rotor winding (‘squirrel-cage’) offer a robust design. An inverter and a cooling device are needed for operation. For minimal losses, the operating mode of the inverter should be coordinated with the motor characteristics. To ensure optimum efficiency under all operating conditions, the traction converter can adjust the magnetic field inside the electric machine. One, two or even more motors can be connected in parallel to one inverter without additional equipment. Optionally, speed and temperature sensors can be utilized.

Permanent magnet synchronous machines (PMSM)

Permanent magnets create a magnetic field in the motor’s core without external control or supply. Very high efficiency values are achievable at low and medium speed or when utilizing the full torque capability. Efficiency at higher speeds with partial load is reduced due to active field weakening and drag losses, caused by the permanent magnetic field. Motor control requires the knowledge of the actual rotor position, subsequently each PMSM needs its own inverter. This is obviously no limitation for vehicles using only one (central) motor.

How to choose the suitable traction alternator?

In the end, it depends on your overall concept and your requirements. Learn more about the different functionalities of our permanent magnet synchronous generators and induction generators (asynchronous generators) in this chapter.



Principle design of a PMSM

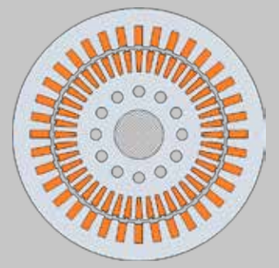
Permanent magnet generators – The functional principle in a nutshell

TSA-made permanent magnet generators are permanent magnet synchronous machines (PMSM) equipped with high-energy permanent magnets inside the rotor. The machines are totally enclosed and typically liquid-cooled. The PMSM is excited by the permanent magnets only. So, there is no separate electric excitation device in the PMSM, nor are there any connections for controlling the excitation.

When turning the rotor with terminals open, an electric voltage will always appear at the terminals due to the permanent magnets. If the rotor is turning and a conductive connection is present, electric current will always flow when the machine is rotating, both in normal operation and in the event of a short circuit.

The electric voltage depends on the speed of the machine. Higher rotating speed equals higher output voltage. The voltage is also dependent on the load – the higher the load, the lower the output voltage. Finally, the voltage depends on the actual temperature of the magnets as well. While the voltage is higher for cold magnets, it decreases when the machine warms up. The impact of this effect depends on the magnet material and should be considered during the design phase.

The permanent magnet generator is normally used together with a passive rectifier (B6 diode bridge), but operation with an active rectifier converter is also possible. In most applications, the passive B6 diode rectifier is used – basically only 6 power diodes are needed to convert the 3 phase AC voltage of the generator into DC voltage. The simple design of the power electronics is one of the major advantages of the permanent magnet generator over the induction generator. However, in this case the output voltage of the machine can only be varied by changing the speed of the machine by altering the revolutions of the combustion engine (ICE). To take account of the voltage variation caused by the load or by the magnet temperature, a wider range for the allowed DC operating voltage is favourable.



Principle design of an IM / ASM

Induction generators (asynchronous generators) – The functional principle in a nutshell

TSA-made induction generators (asynchronous generators) are equipped with squirrel-cages made of copper bars and rings. There are neither permanent magnets nor slip rings. When turning the rotor with terminals open, no electric voltage will appear at the terminals.

For the generator to produce electrical power, it is necessary to create a magnetic field inside the machine. In the case of a traction generator, where no public grid is available, the 3-phase supply for the excitation is provided from a DC source by a variable voltage variable frequency converter (VVVF). Once this 3-phase supply has been connected to the asynchronous machine, the traction alternator can deliver electrical power to the converter. It is not possible to simply connect the asynchronous machine to a passive rectifier (B6 diode bridge).

Technology Range and Applications

Manufacturers and operators of rail vehicles and buses across the globe rely on the products and services of Traktionssysteme Austria. Our technology and equipment has been in use successfully for more than 60 years. We contribute to making electric mobility more efficient, more reliable and more powerful.

Trams, LRVs, Streetcars

Metros

EMUs DEMUs

Locos

Intercity, HS and VHS Trains

Monorails

Maintenance of way vehicles

eBuses

Liquid cooling	*	*	*			*	*	*
Air cooling	*	*	*	*	*	*	*	*
Wheel-hub drives	*					*		*
Generators (AC and PM)			*	*	*		*	
Gearboxes	*	*	*	*	*		*	
Integrated drives		*	*	*	*		*	
PM Technology	*		*	*	*		*	*
Overhauls / Refurbishment	*	*	*	*	*	*	*	*
Service contracts	*	*	*	*	*	*	*	*

* Research & Development, Design, Production, Assembly, Testing and Service & Maintenance by Traktionssysteme Austria

International quality
Made in Austria

Optimum quality is no coincidence. In achieving this, we adhere not only to legal requirements but also to international standards and norms. We work continuously to improve and achieve further certifications.

Our integrated Quality Management System is rooted in the ISO 9001 Certification. As an innovative company, in 2008 we were Austria's first enterprise to have its management system certified according to the ISO/TS 22163 (IRIS).

Ever since that time we have been working on the enhancement of our management system, including measures to comply with the provisions of both ISO 14001 Environmental Management and ISO 50001 Energy Management standards.

International quality made in Austria –
these certificates confirm our performance:

- ISO TS 22163:2017 (IRIS)
- EN 15085-2
- ISO 9001:2015
- ISO 14001:2015
- ISO 50001:2011
- Declaration of conformity for
  - REACH
  - RoHS
  - Conflict Minerals

Our products move rail cars and electric buses
on every continent in more than 60 countries.

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TSA on Social Media

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