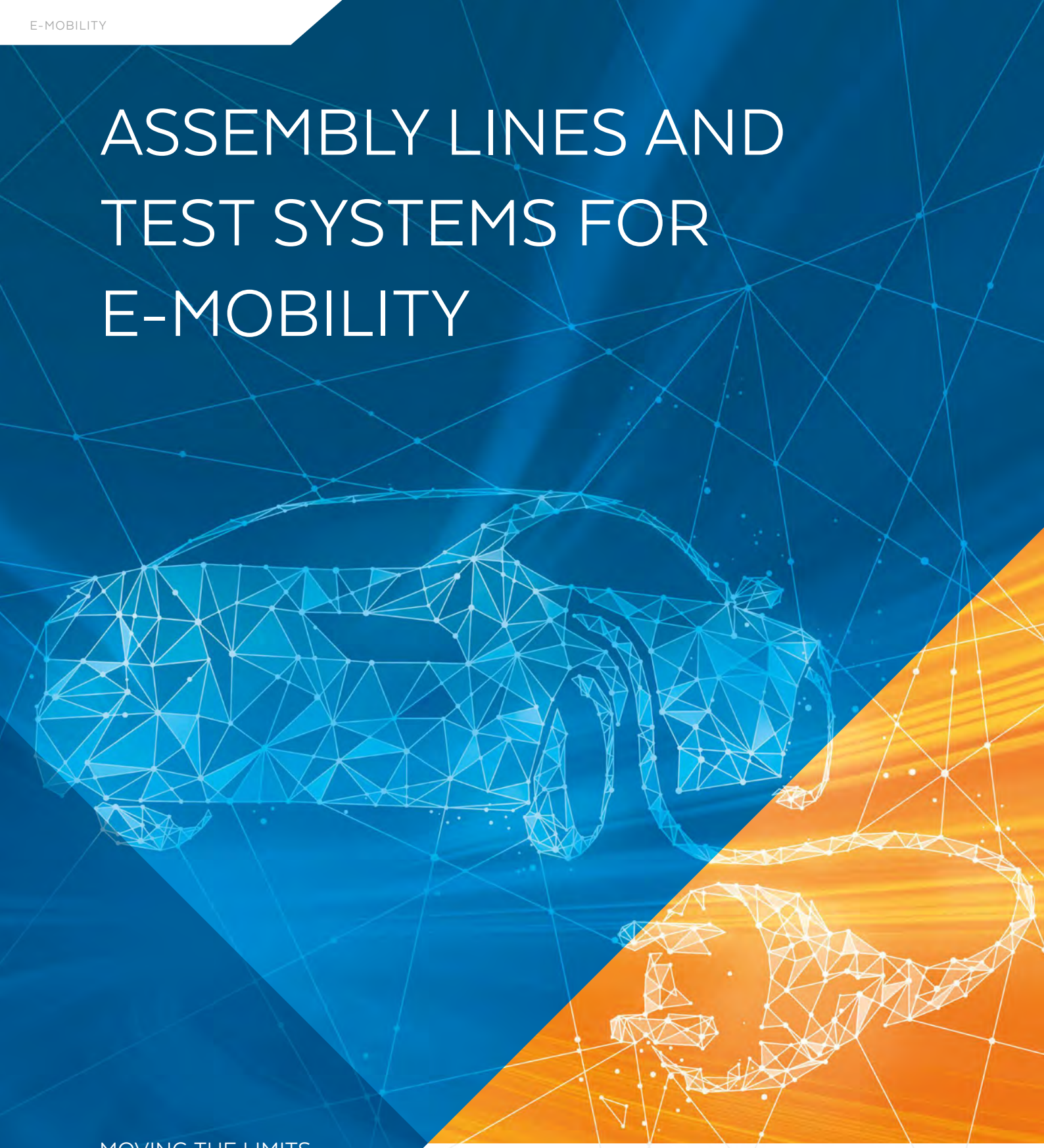
ASSEMBLY LINES AND TEST SYSTEMS FOR E-MOBILITY

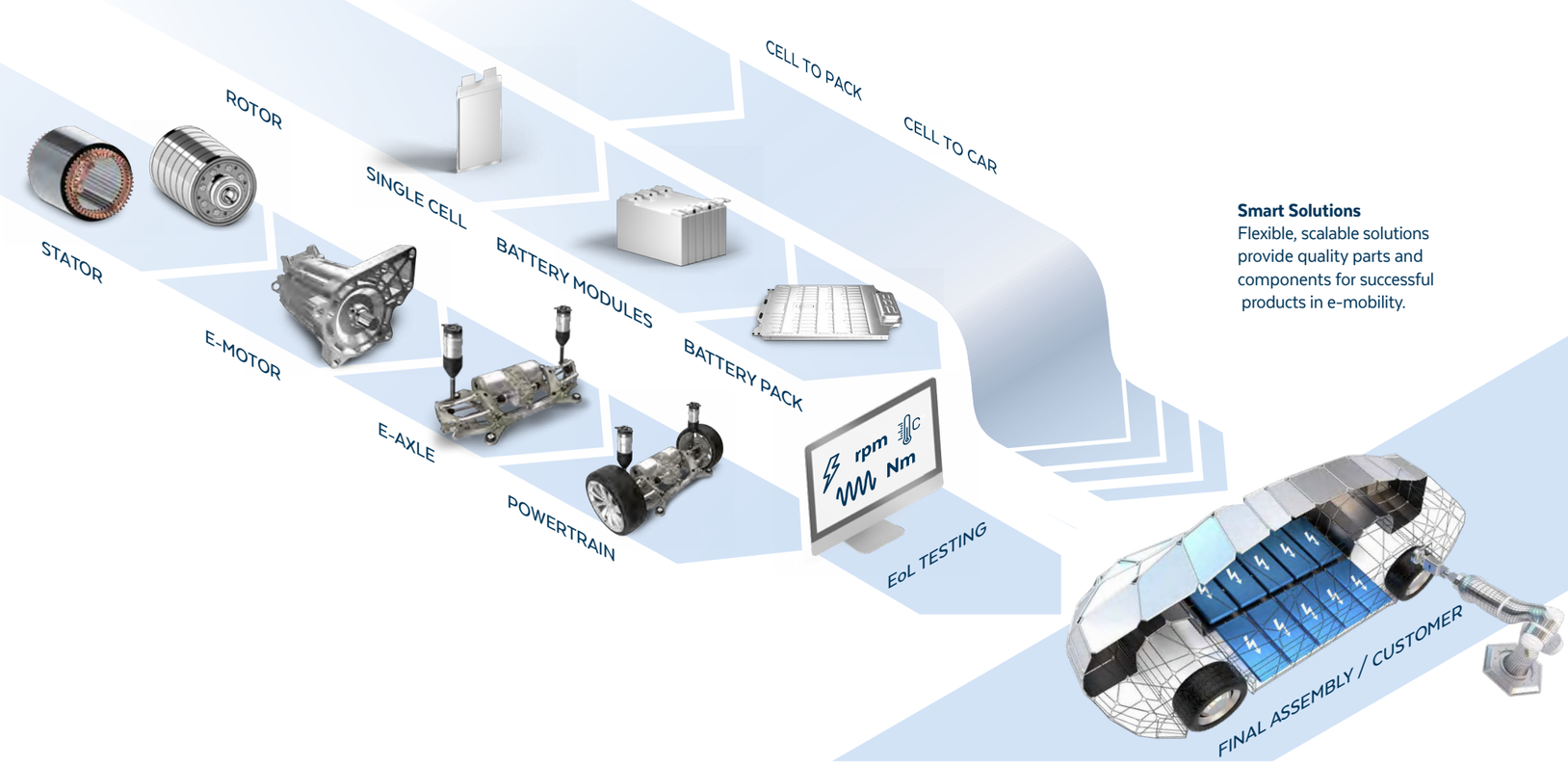


MOVING THE LIMITS.
TOGETHER.
CONSTANTLY.

STRAMAMPS

SCALABLE FOR EVERY DEMAND

E-mobility is coming. It's booming. But nobody can say exactly how quickly the journey with electric cars will begin. Fact is: E-mobility offers enormous opportunities for those who are well prepared.



Smart Solutions
Flexible, scalable solutions provide quality parts and components for successful products in e-mobility.

E-mobility puts the automotive industry to the test
Time-to-market is crucial for both manufacturers and suppliers. At the same time, however, nobody knows exactly how the market will develop. It is difficult to forecast future demand quantities. Which production capacities should you invest in without sacrificing capital through excessive investments or business potential due to insufficient production capacity?

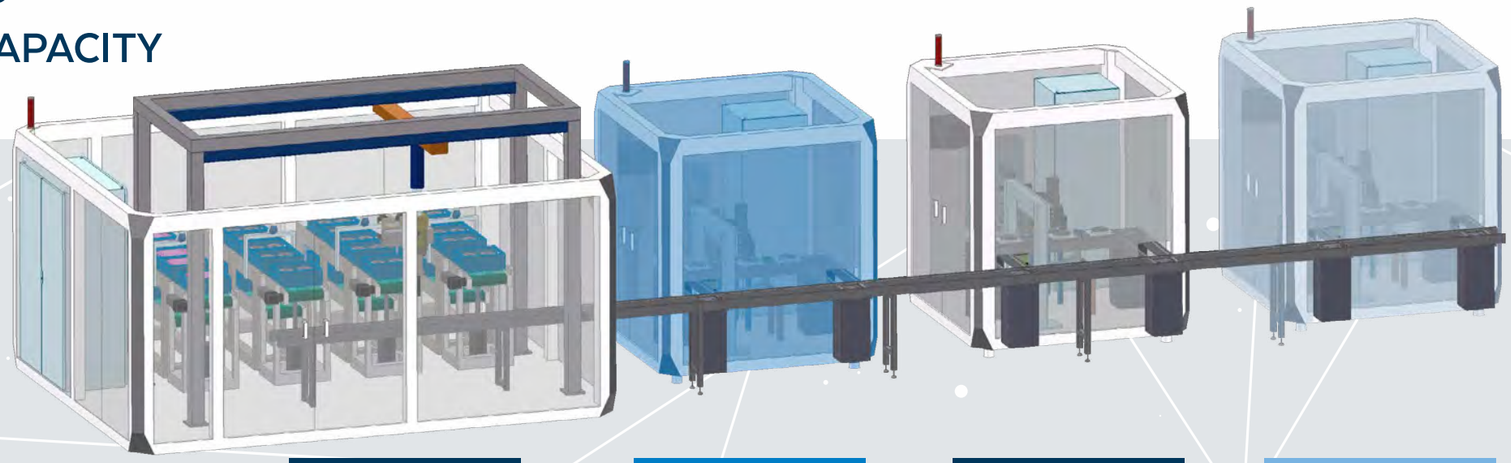
The future therefore is in scalable lines
We plan and implement them. The basis for this is a modern assembly and testing system, the basic version of which covers all process steps. It is designed for high product quality and system availability and can be scaled along the entire value chain. For this, technology cells are added gradually until the desired output quantity (target capacity) is reached.

Several years of expertise in e-mobility
More than five years ago, Strama-MPS noticed the opportunities in e-mobility and began developing and manufacturing scalable production systems. Whether for energy storage systems or powertrains: Our systems enable economical production with maximum flexibility and to the highest quality standards.

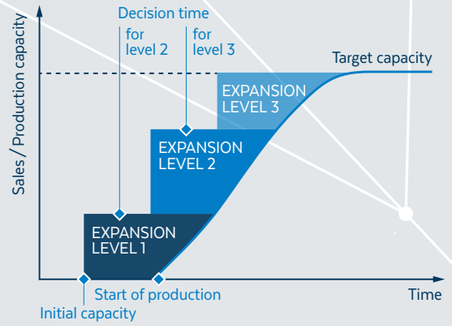
Appealing concept not only for car manufacturers
The efficient use of capital and adjustable output make our assembly systems equally appealing to OEM, Tier 1, start-up companies and assemblers.

STEP BY STEP TO TARGET CAPACITY

The technology cells can be supplemented until the desired target capacity is reached in accordance with current and future demands and requirement quantities.



Scalability without limits
If all expansion levels are in use and even higher demand quantities develop in the long term, the line can be duplicated in parallel with ongoing production.



MAXIMUM POWER FOR MAXIMUM RANGE

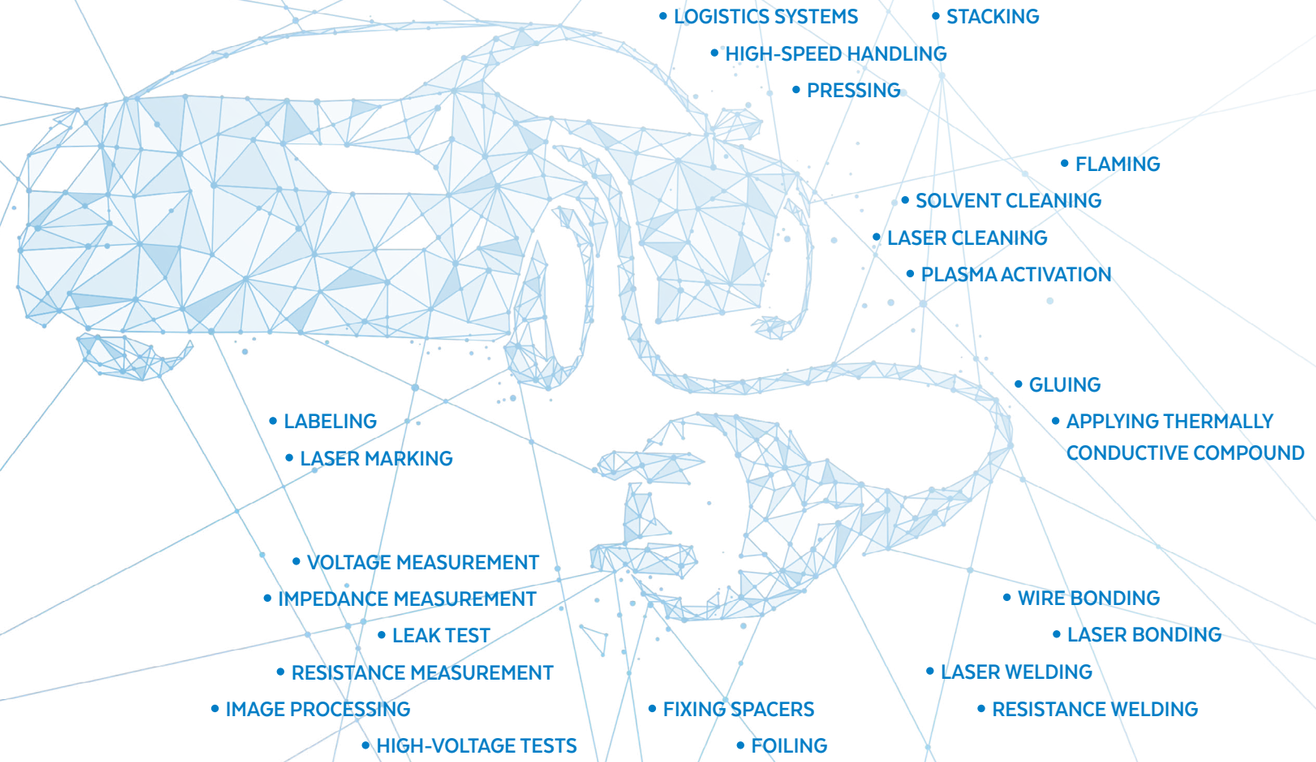
The range of electric vehicles depends strongly on the performance of the energy storage systems used. With our assembly lines and test systems we ensure expanding horizons.

Strama-MPS supplies turnkey assembly lines for the pre-assembly of battery modules and the final assembly of battery systems for electric and hybrid vehicles. Our solutions are characterized by high throughput rates, flexible assembly strategies, intelligent test processes and monitored assembly steps. We combine years of experience in the fields of automation, logistical linking, measurement and testing technology as well as high-voltage technology.

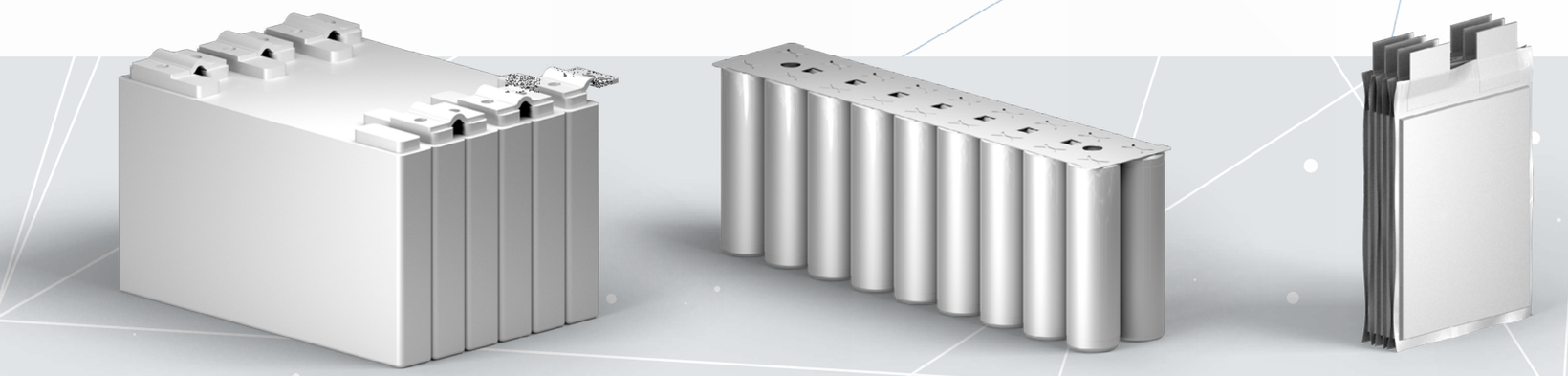
BATTERY MODULE ASSEMBLY LINES

In our assembly lines for battery modules we use state-of-the-art equipment to process high-quality prismatic, cylindrical and pouch cells. The cells are stacked at high speed and electrically connected. The product portfolio includes: Wire bonding, laser bonding, resistance welding and laser welding. Length and width of the stacks are almost freely configurable. All modules undergo a 100 % function test before being passed on to subsequent processes. Industry 4.0 and a consistent traceability are standard in all of our systems.

State-of-the-art processes for battery module assembly:



The processing of battery cells requires specific process knowhow and a lot of experience. That is exactly what makes us a leader in engineering. We are thus achieving that finally the full power can be utilized in electric vehicles – at any time and permanently. Even critical issues, such as swelling, overheating, short circuits and salification can be consistently solved with our assembly systems.



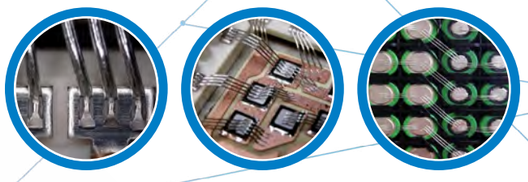
Highlights

- Manufacturing of battery modules from prismatic, cylindrical and pouch cells
- Cell stacking by use of state-of-the-art equipment
- High-speed stacking of cells
- Establishing electrical connections by means of laser welding
- Future-proof production strategy by variable length and width
- 100 % testing of the modules prior to delivery
- Trackability and traceability
- Full integration of manual workstations, screen-based worker guidance
- Individually adaptable logistics concept: robot, belt system, trolley, etc.

INNOVATIVE CONNECTION TECHNOLOGY FOR E-MOBILITY

The quality of electrical connections plays a decisive role for the performance and range of electric vehicles. That is why we use state-of-the-art joining methods for the assembly and wiring of battery modules and battery packs, such as ultrasonic wire bonding, laser bonding and laser tab welding.

Flexible surfaces, slight surface impurities and differences in height are thus managed just as confidently as a precise position detection and control. F & K DELVOTEC is a subsidiary of the Strama Group and with more than 40 years of experience the recognized international technology leader in ultrasonic wire and laser bonding.



Ultrasonic Wire Bonding

Ultrasonic wire bonding is the preferred method for the wiring of electrical contacts in sensitive sensor systems, semi-conductor and control electronics.

Wires up to 20 A or ribbons of aluminium or copper can thus be processed flexibly. The energy input into the cell is low. The investment pays off quickly thanks to high productivity.

Laser Bonding

Laser bonding is the leading connection technology, which is used wherever large cable cross sections are required for a high power transmission. Wires up to 60 A and ribbons up to 10 x 0.5 mm of aluminium or copper can be connected without problems according to the current development status. As an alternative – depending on the requirement and product – Laser-TAB bonding is also available for any cross sections.

MARKET-SPECIFIC SOLUTIONS FOR THE INDUSTRY

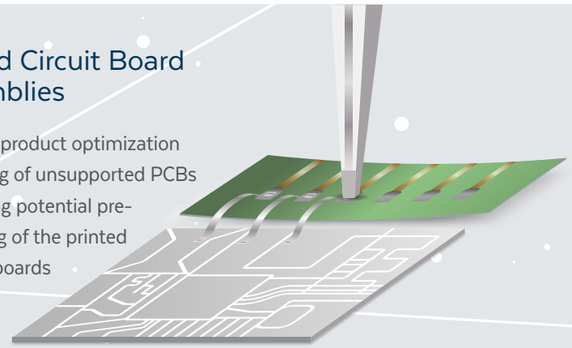
Our connection technologies are used for a wide variety of industrial applications – also in the production of powertrains, sensors, control units and other electronic devices.

Strama-MPS has many years of experience in integrating all common and innovative processes.

- LASER BONDING OF RIBBONS
- LASER-TAB WELDING
- ULTRASONIC BONDING OF THIN WIRE CONNECTIONS
- ULTRASONIC BONDING OF THICK WIRE CONNECTIONS
- ULTRASONIC BONDING OF HEAVY RIBBONS
- COPPER CONNECTIONS
- ALUMINIUM CONNECTIONS
- GOLD CONNECTIONS
- HILUMIN CONNECTIONS
- PROCESS SIMPLIFICATION
- EXCELLENT HEIGHT TOLERANCE
- NO ADDITIONAL COMPONENTS
- NO CLAMPING

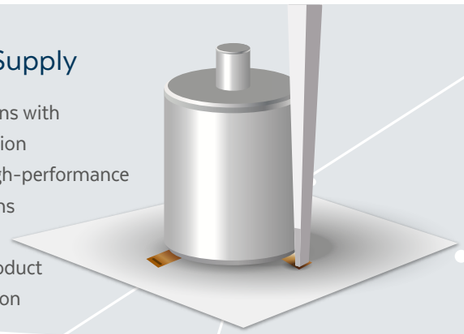
Printed Circuit Board Assemblies

- Simple product optimization
- Bonding of unsupported PCBs
- Avoiding potential pre-cleaning of the printed circuit boards



Energy Supply

- Connections with low induction
- Simple high-performance connections
- Simple product optimization

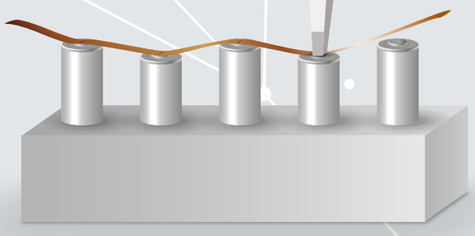


Flexible Printed Boards

- Welding depth precision
- High-quality connections
- Simple product optimization

Cylindrical Cells

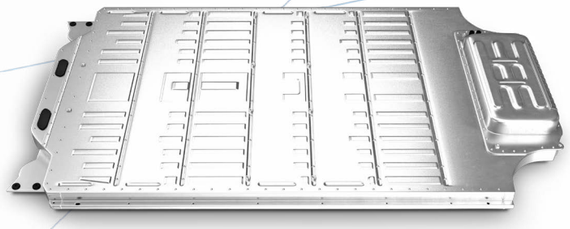
- Maximum throughput
- Maximum yield
- Lowest downtime



BATTERY PACK ASSEMBLY LINES

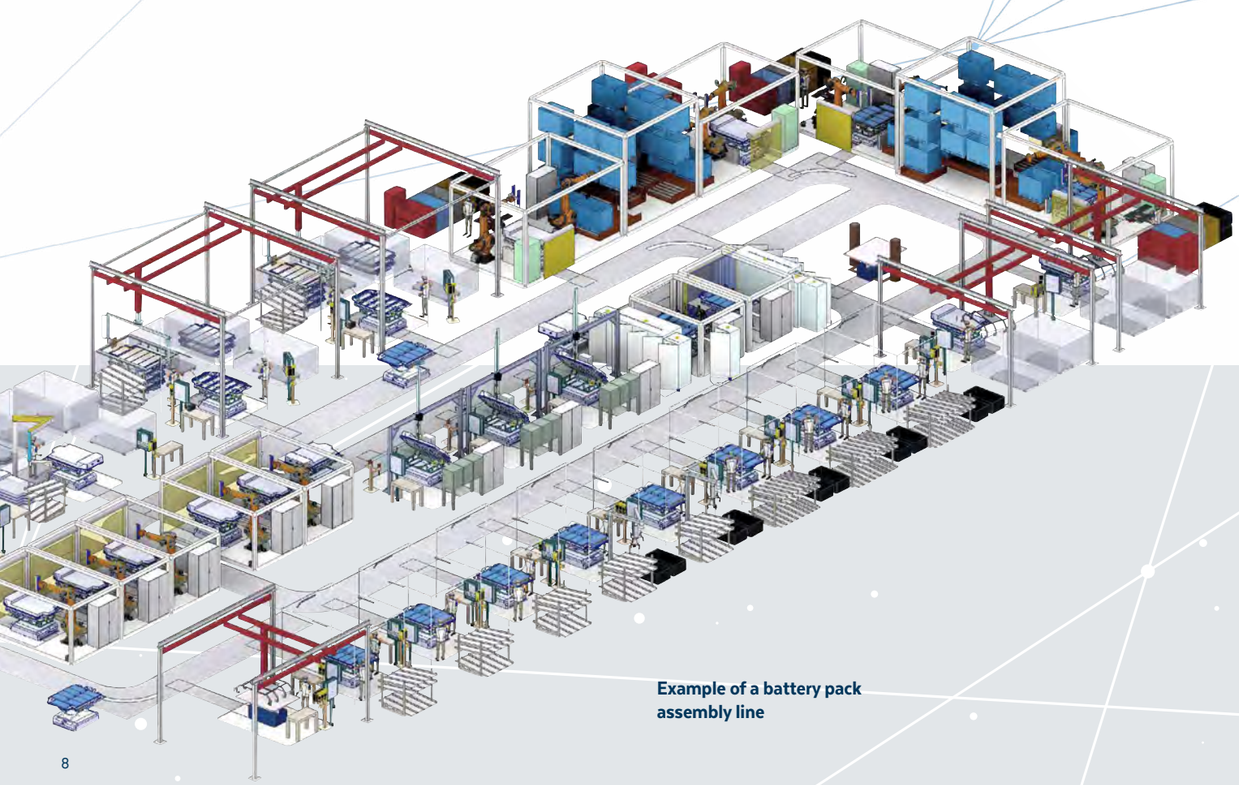
In our assembly lines for battery packs the modules are fed into the stations either manually or via specifically developed supply systems. Identification, sorting, positioning, fixing and connecting of the modules carried out fully automatically.

Other components, such as cooling systems, ventilation bodies, connectors, wiring harnesses, etc. can be mounted manually or automatically. This involves an inspection step after each assembly station to ensure a zero defect production.



Today's battery systems are essential, complex and multi-functional modules in electric vehicles. With our assembly lines, the vehicle manufacturers and component suppliers may quickly and easily implement their development ideas.

Also for the production of battery trays, we deliver efficient solutions that combine precision with effectiveness and fulfill the highest standards in terms of cleanliness, leak tightness and safety.



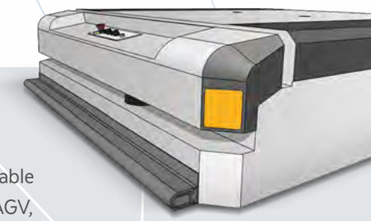
Example of a battery pack assembly line

State-of-the-art processes for battery pack assembly:

- WIRE BONDING
- LASER BONDING
- LASER WELDING
- ULTRASONIC WELDING
- LEAK TEST
- HIGH-VOLTAGE TESTS
- RESISTANCE MEASUREMENT
- FLASHING
- IMAGE PROCESSING
- COMMUNICATION TEST
- INSTALLING WIRING HARNESSES
- LOGISTICS SYSTEMS
- POSITIONING MODULES
- HANDLING OF LARGE COMPONENTS
- BOLTING
- GLUING
- IONIZING
- THERMALLY CONDUCTIVE PASTE APPLICATION
- SEALANT APPLICATION
- VACCUM CLEANING
- LASER CLEANING
- PLASMA ACTIVATION
- LABELING
- LASER MARKING

Highlights

- Processing of battery modules to battery packs
- 100 % testing of the packs prior to delivery
- Full integration of manual workstations, screen-based worker guidance
- Trackability and traceability
- Individually adaptable logistics concept: AGV, robot, belt system, trolley, etc.

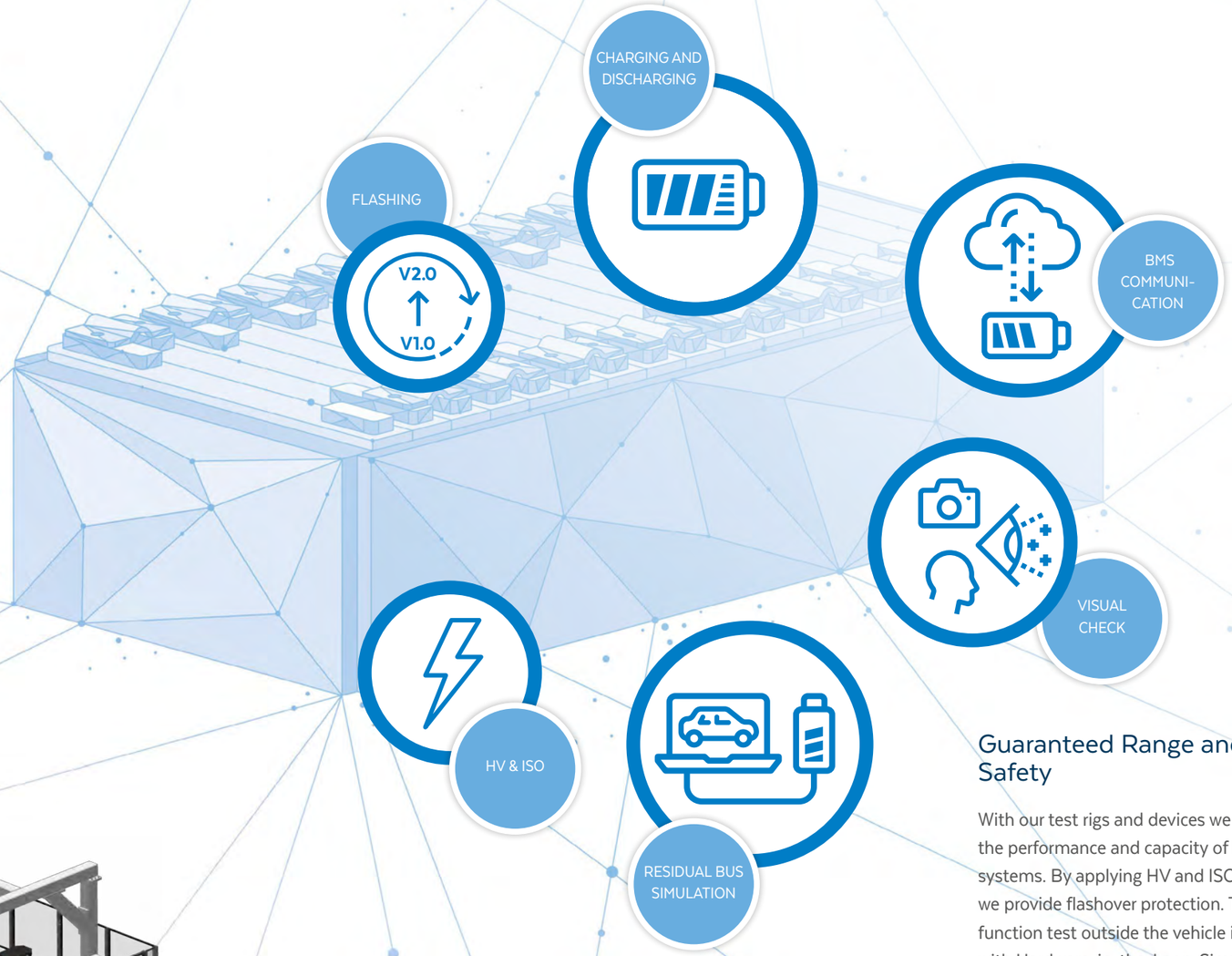


TEST SYSTEMS FOR BATTERY ASSEMBLY

As a system supplier we also offer modern test systems for module and pack assembly lines. This allows a perfect carrying-out of all target-oriented Begin-of-Line-Tests (BoL), inline function tests and the final End-of-Line-Tests (EoL).
Quality gates can be defined during the inline function tests and, for example, resistance measurements and leak tests be made. Interim tests secure the value-added chain in every process step. Potential faults can be detected and eliminated at an early stage. EoL test rigs ensure the overall functionality of assembly and safety systems. For contacting special connectors are used. These enable realizing – maintenance-free – several hundred thousand mating cycles.

Test protocols for every task
Today, bus systems are used for exchanging signals in vehicles. Based on the application and requirement (such as safety-critical applications, high data transfer volumes, flash programming capability or cost aspects) different test and communication protocols are used.

We integrate the protocol that optimally suits your individual testing tasks into the EoL tester. The outside world and its influences are simulated via a residual bus simulation.

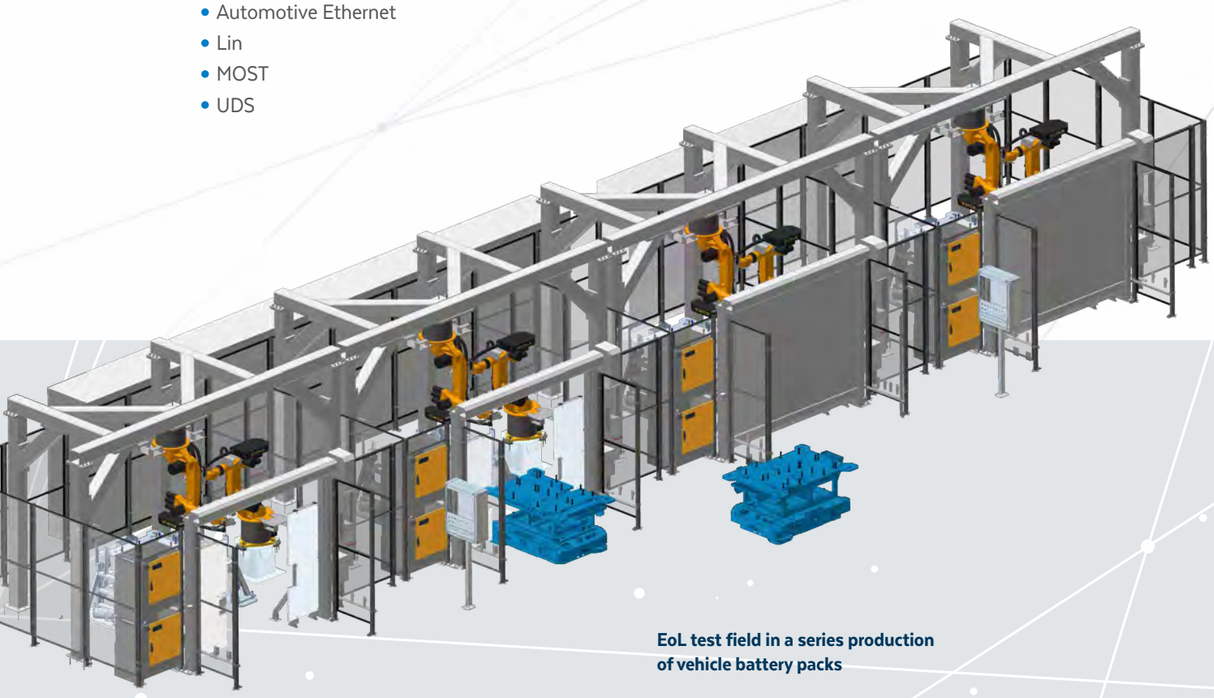


Communication Protocols

- CAN (CAN – FD, XCP)
- FlexRay
- Automotive Ethernet
- Lin
- MOST
- UDS

Key Figures

- Power: 1200 A
- Voltage: 1200 V DC

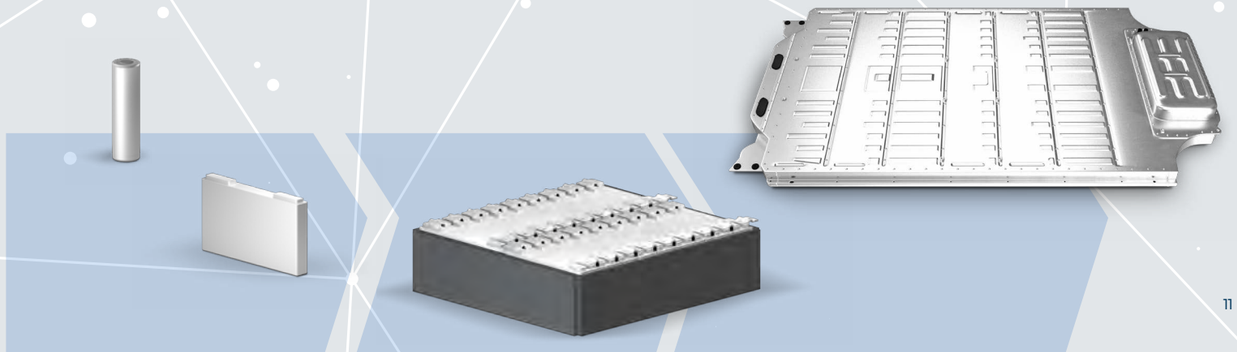


EoL test field in a series production of vehicle battery packs

Guaranteed Range and Safety

With our test rigs and devices we ensure the performance and capacity of battery systems. By applying HV and ISO tests we provide flashover protection. The function test outside the vehicle is made with Hardware-in-the-Loop-Simulations (HiL). The proper functioning of the safety shutdowns is also checked in this process – for example the temperature and crash sensors.

Tests: From: Begin-of-Line Test (BoL) – to: Inline function tests / quality gates – all the way up to: EoL test



INTELLIGENT SOLUTIONS FOR EFFICIENT PROCESSES

Improved driving dynamics by innovative electric drive concepts. They will revolutionize both the driving experience and the automotive industry. We deliver the assembly technology.

Compared to combustion engines, electric drives are simple and cost-effective components. This will lead to increased competition in this segment, decentralization of the production and further modularization in auto manufacturing. This calls for innovative concepts that combine efficiency, flexibility, quality and precision. Our turnkey assembly lines for e-axles, e-motors, stators and rotors offer this combination to our customers. The relatively high standardization in this segment enables us to guarantee the shortest project and delivery times. We offer you the design, engineering, production and commissioning of all production processes for the e-motor and e-axle assembly in the perfect Strama-MPS quality.

ASSEMBLY LINES FOR ROTORS

Basic requirement for a high-quality rotor production is the reliable supply and fitting of the stacks with magnets. Shafts and rotors are assembled in our production lines under strict quality control. The components are fixed by means of specifically designed joining technologies, such as bolting, gluing and pressing. Balancing is carried out fully automatically – as option, an additive or subtractive process. Magnetizing is individually adaptable.

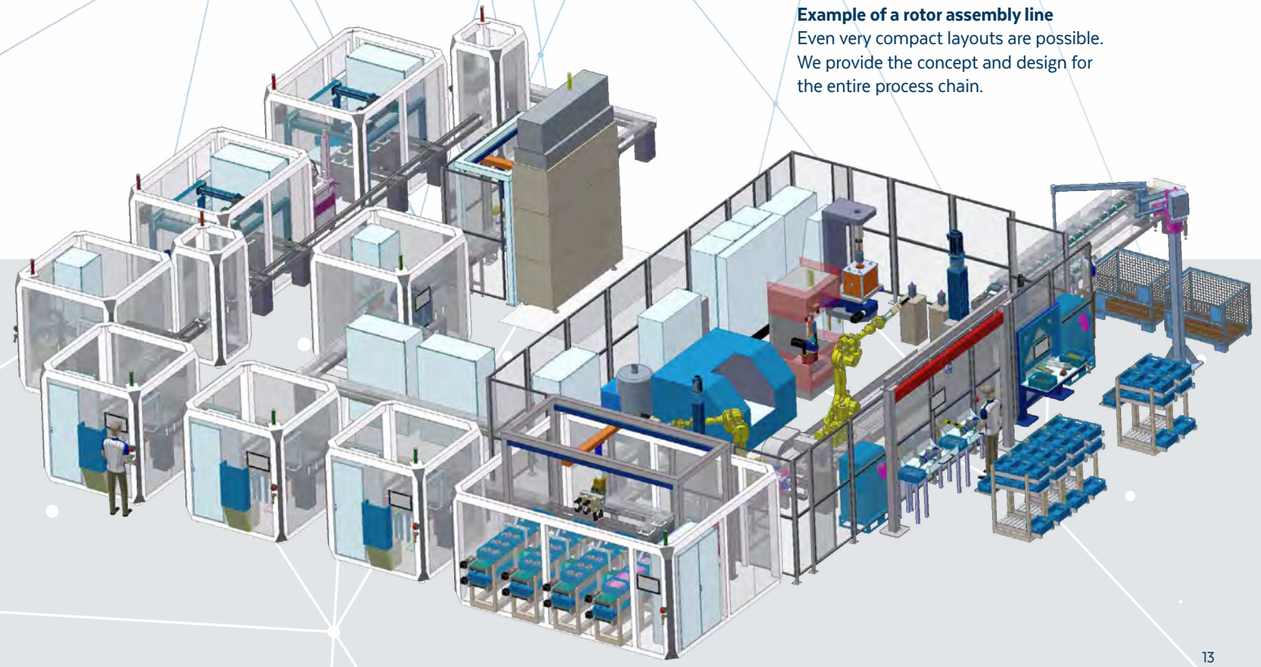
Even functional tests, e.g. of the press-out forces, the balance quality or the magnetization, are integrated by us into the process according to your needs.

Assembled and balanced rotor – ready for installation

Highlights

- High-speed handling for inserting magnets
- Highly automated stacking
- Diverse fixing technologies
- 100 % test of balance quality and field strength
- Trackability and traceability
- Individually adaptable logistics concept: Robot, belt system, etc.

State-of-the-art processes for rotor production:



Example of a rotor assembly line
Even very compact layouts are possible. We provide the concept and design for the entire process chain.

ASSEMBLY LINES FOR STATORS

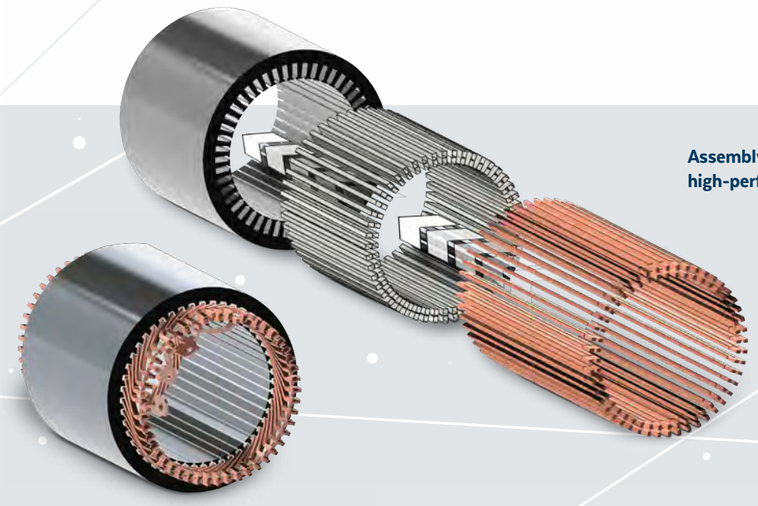
Demands to power density and system weight are becoming increasingly higher. Therefore, an agile and innovative engineering in motor development is also required. The power potential of stators can be significantly increased using new winding methods and the pin technology with rectangular wires. We can provide you with the assembly and connection technology. Processes, such as the stripping of copper wires, the twisting of pins or the contacting by means of ultrasonic laser bonder or wire bonder, have been completely automated. We also specifically design impregnation machines for your products and integrate them seamlessly into the production line.

State-of-the-art processes for stator production:

- LASER WELDING
- GLUING
- BOLTING
- BEARING ASSEMBLY
- PIN PREPARATION
- TWISTING
- PRESSING
- HARDENING

Highlights

- Integration of all process and test steps of stator production
- Production of different pin shapes (U / I / Hair)
- Inline pin – variant production from the coil
- Electrical connections using state-of-the-art bonding processes
- Modular design for individual ramp-up-scenarios
- High-speed processes “on the fly”
- Trackability and traceability
- Inline quality inspection



Assembly scheme of a high-performance stator

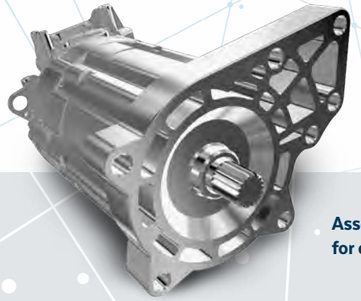
ASSEMBLY LINES FOR E-MOTORS INCLUDING TRANSMISSIONS AND E-AXLES

As a leading system supplier in e-mobility we develop and realize highly modern assembly lines for you, which are flexible enough for a production of varying types of powertrains. Centerpieces are the stations for the assembly of electric motors.

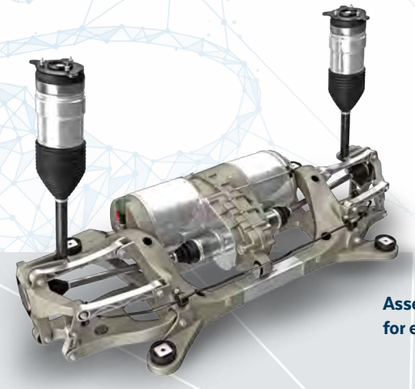
Transmission assembly, inverter manufacturing and End-of-Line testing of the powertrain are also perfectly covered by our modular technology platform.

State-of-the-art processes for e-motor assembly:

- INSTALLING CABLE HARNESSES
- LOGISTICS SYSTEMS
- HANDLING OF LARGE COMPONENTS
- COMPONENT HANDLING
- LEAK TEST
- HV & ISO TESTS
- FLASHING
- SEAL MOUNTING



Assembly lines for e-motors



Assembly lines for e-axles

Highlights

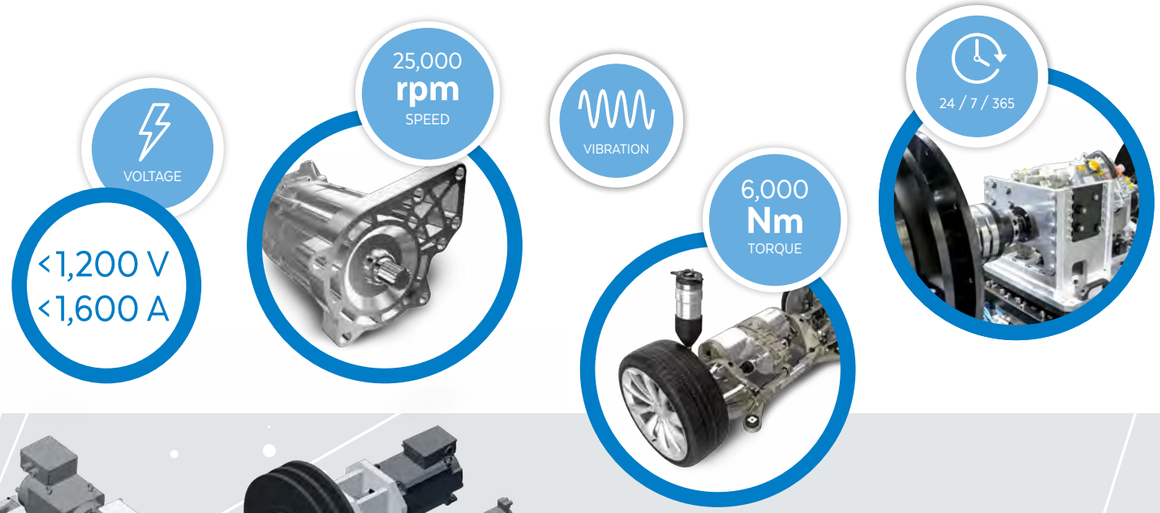
- Turnkey assembly lines entirely from a single source
- Integrated inline- and EoL tests to ensure the functionality and product quality
- Flashing of software version
- Optimum handling of large components
- Human-robot collaboration
- Individual automation level

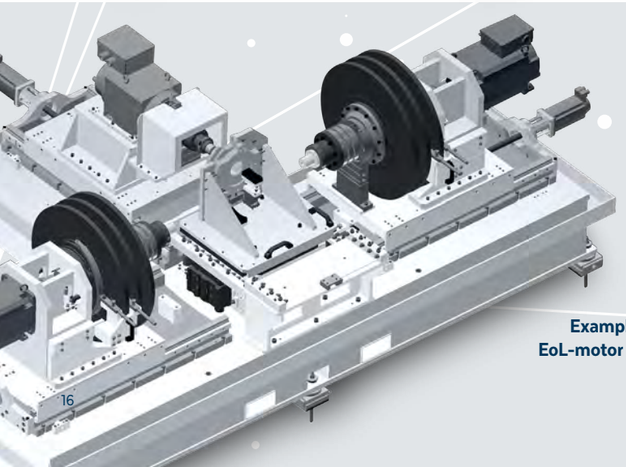
PRECISION THANKS TO QUALITY TEST RIGS

E-mobility sets high standards for the quality of components and motors. Those who want to meet these standards need a high-level production technology – consistently up to the end-of-line test.

Our end-of-line test rigs for e-motors and e-axles were specifically developed for the high standards of e-mobility. They can be applied both in development and in automatic series production. Equipped with various measuring systems, electrical as well as mechanical tests can be carried out. The high quality and robust construction prevents deformations, oscillations and vibrations. This ensures precise measurements and significant tests with a high reproducibility.

Perfect integration into your line
With our test rigs we cover the complete range of e-drives. Whether e-bike, HEV- and BEV-drives or e-axles for trucks – we offer you exactly the development and series test rigs that fit your test requirements and production conditions. As experienced automation specialists, we integrate the test rigs optimally into your material flow. For a maximum type flexibility we offer you adaptable test specimen holders and media supply solutions.





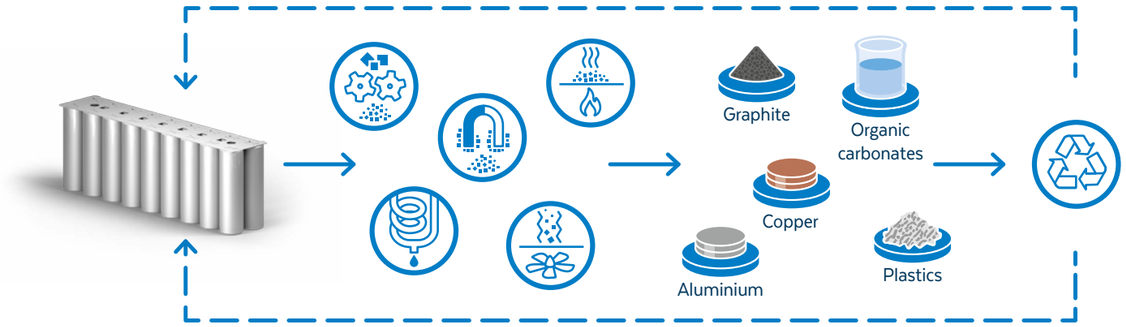
Example of an EoL-motor test rig

Providing power and precision on the test rig
Besides measuring of the system performance and sudden load variations, it is also possible to perform torque tests and torque ripple tests, NVH and winding tests as well as high-voltage and insulation tests.

NEW DEVELOPMENTS AND TRENDS

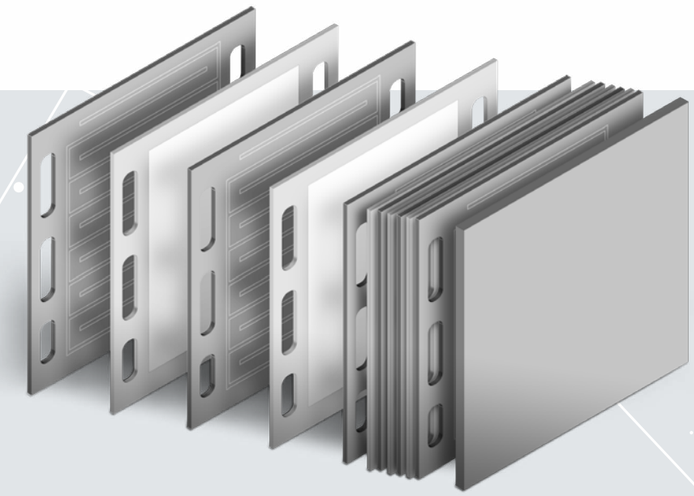
RECYCLING OF BATTERY SYSTEMS

Strama-MPS is also your reliable system partner, when it comes to the development of equipment for battery recycling. With modern, graduated methods we bring organic substrates, metals, graphite and cathodic materials back into the material cycle – and thus ensure sustainability and economic efficiency.



STACKING OF FUEL CELLS

When reliable solutions for the series production assembly are required, this is a core competency of Strama-MPS. Also, if you want fuel cells to be stacked. We develop integrated automation and test systems for you – for every shape and size of fuel cell stacks.



PROCESS AND DIGITALIZATION TECHNOLOGY

To establish very promising, economical and sustainable solutions for the mechanical and plant engineering industry, the Strama Group founded a powerful organizational unit, promoting the visions of the mechanical engineering world and exploiting all possibilities and opportunities of digital transformation.

Digitalization and simulation
Kinematization, plant simulation, virtual commissioning or development of a digital twin: tools of the digital world are widely featured. Strama-MPS develops and uses them. In this way, potentials can be identified at an early stage and the processing times in development be reduced significantly. Take advantage of this already in the initial stage of your product realization and thus reduce your TCO (Total Cost of Ownership).

Process technology and expertise
Anyone who wants to develop leading technology solutions must also master the complex mechatronic processes. This is the core competency of our specialists at Strama-MPS.

Benefit from our know-how and our experience in the sectors

- Laser systems technology
- Measuring technology
- High- and low voltage technology
- Metallography
- Safety engineering
- Image processing systems
- CNC-Machining
- Inhouse production

With our consistent FMEA strategy we maximize the machinery and equipment quality and avoid product failures.

OUR STRAMA-MPS SERVICE

Individual assembly concept for your application
We prepare an individual assembly concept for your product with customized logistic solution.

Worldwide 24/7 service
Our service is available to you around the clock, seven days a week. Our locations in Germany, China, USA and Mexico guarantee short response times and local contacts worldwide.

WE DO NOT ONLY BUILD SPECIAL MACHINES

We provide advantages throughout the entire production process.

Special machines, equipment and complete solutions for more than
70 YEARS

From the planning to the plant ready for production – all from a single source,
100 % RELIABLE

Efficiency Engineering and state-of-the art technologies worldwide at
10 LOCATIONS

Globally operating with 14 companies in 8 countries on
3 CONTINENTS

Optimally positioned for the project success with approximately
1,350 EMPLOYEES

Long-term partnerships with our customers, thereof
90 % REGULAR CUSTOMERS

Making projects successful right along the line

Innovation is our strength. Efficient engineering our passion. We think globally and act locally. This is how we stand by our customers worldwide – and offer them at the hot spots of the world markets quality and service “Made in Germany”. Unbeatable in response time and promptness, we realize intelligent ideas and economical solutions for a significant competitive advantage.

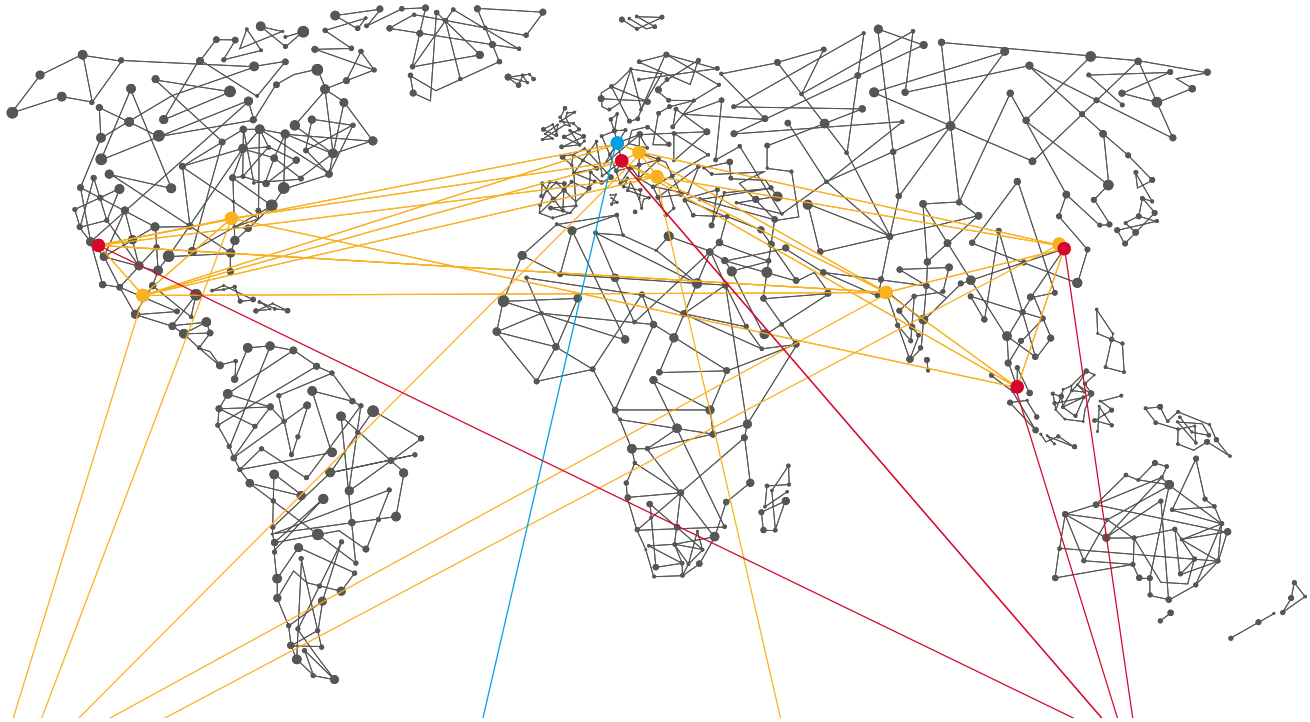
Benefit from this.

POWERFUL SYNERGIES: “MEMBER OF STRAMA GROUP”

Strama-MPS develops special-purpose machinery, equipment and complete solutions for the production, assembly and testing of complex technical components and products. International technology groups appreciate our engineering expertise, the experience and the certainty: We lead your project to success.

AuE Kassel has acquired in recent years an excellent reputation with assembly lines for axles and chassis components in the passenger car and commercial vehicle sector. With its axle alignment systems AuE has long been the world market leader.

For more than 40 years, **F & K DELVOTEC** is the worldwide innovation leader for wire and laser bonders. Renowned companies and research institutes worldwide are convinced by the quality of the technology and engineering services.



STRAMAMPS

GERMANY, Straubing
CHINA, Taicang
USA, Duncan
MEXICO, Puebla
INDIA, Nashik

STRAMASUMMIT

AE automation+engineering

GERMANY, Kassel

NEXUS

CROATIA, Cerna

F&K DELVOTEC

GERMANY, Ottobrunn
USA, Foothill Ranch
CHINA, Taicang
SINGAPORE

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