The Drive & Control Company

Rexroth
Bosch Group

# Modern Energy Storage Production – Efficient and Cutting-Edge

## More standardization and flexibility in handling and automation for your production processes

# Increase efficiency and reduce costs with future-proof production solutions for modern energy storage

Renewables are increasingly important. Innovative electrical energy storage concepts for electromobility based on renewable energy sources in stationary storage units are revolutionizing our energy management systems. Linking these systems with smart grid concepts is no longer a futuristic ideal. Efficient approaches for the economical production and qualitative enhancement of storage technologies are in demand. Rexroth is well acquainted with these market requirements and develops customized solutions tailored to specific battery production processes.

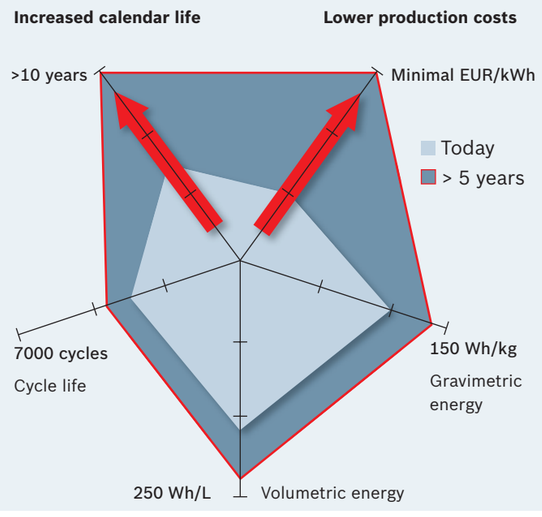
**Expertise in cross-technology and automation solutions – in countless industries**

Rexroth is a strong partner with extensive technological expertise in implementing highly efficient production systems for stationary and mobile energy storage technology. This means our customers can

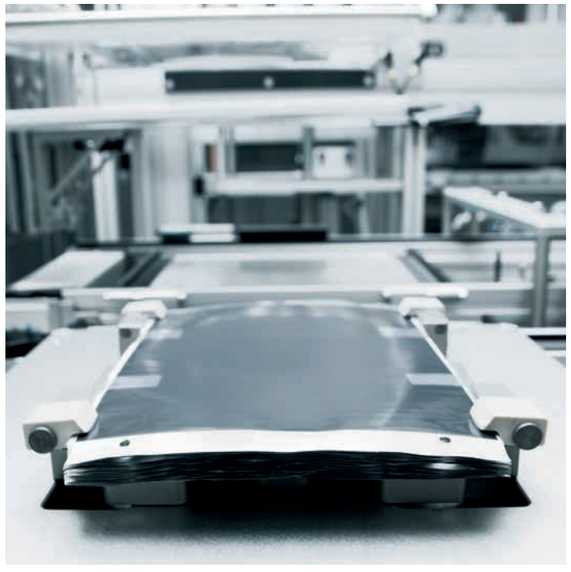
- Reduce manufacturing costs thanks to more efficient processes
- Considerably enhance the quality and service life of their products and benefit from optimized solutions for specific processes through cross-technology standards

Rexroth is a leader in the field of automation technology and possesses long-term experience in a wide variety of industries. As a highly diversified multi-technology provider, we are a competent partner for our customers worldwide.

**Strategic objectives for batteries**



# Custom solutions for your core requirements



**Dry room: maximum production reliability for highly demanding process conditions**

Production processes are critical to increasing life cycles and energy density. These high standards can only be achieved under special dry room conditions:

- Satisfies the highest requirements at air humidities well below 1%
- Uses production resources specifically developed for dry room conditions, i.e. elements and materials including plastic, rubber, adhesives, lubricants, and sealants
- Ensures certified, high-quality components for optimum reproducibility of all processes

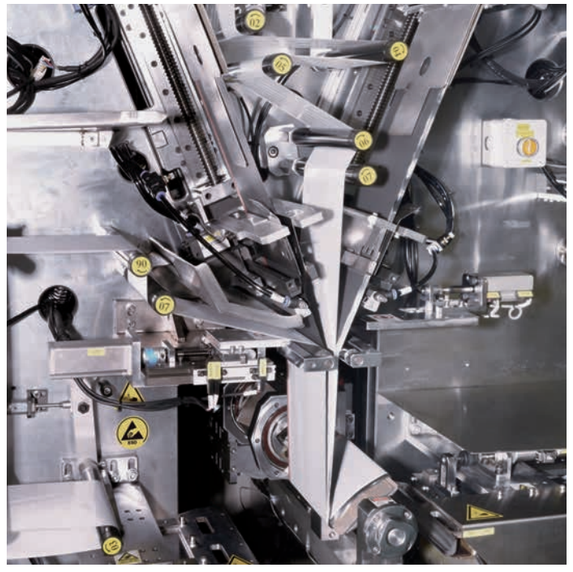
Trapped humidity can corrode electrolytes and must be reliably prevented. Rexroth offers premium technology for safe production, perfectly suited for dry room conditions and proven many times over.

**Cleanroom: the perfect conditions to ensure top quality and your competitive edge**

Excellent quality is an imperative for maximizing output and increasing cost efficiency. Even minimal contamination during the assembly process upsets this delicate balance. Ensure the best prerequisites for your process environment:

- Proven components for flawless production quality under cleanroom conditions
- ESD protection throughout the process chain

Contamination, i.e. the inclusion of particles larger than 10 µm, can result in short circuits and considerably reduce the service life of the energy storage unit. Thanks to our decades of experience with high-grade automation and drive technologies for cleanrooms, we can provide reliable, high-quality solutions.



**Top precision: state-of-the-art technologies give you the edge**

Precision and production reliability are two key prerequisites for market-oriented production. We use our engineering expertise to create powerful processes with seamless quality assurance:

- Proven, ultra-precise technologies for superb cell quality
- Decades of multi-technology expertise

Rexroth can draw from in-depth experience from the roll-to-roll process in print. This provides unbeatable advantages for high-precision electrode coating. Cross-technology control solutions also enable the exact synchronization of electrical and hydraulic axes.

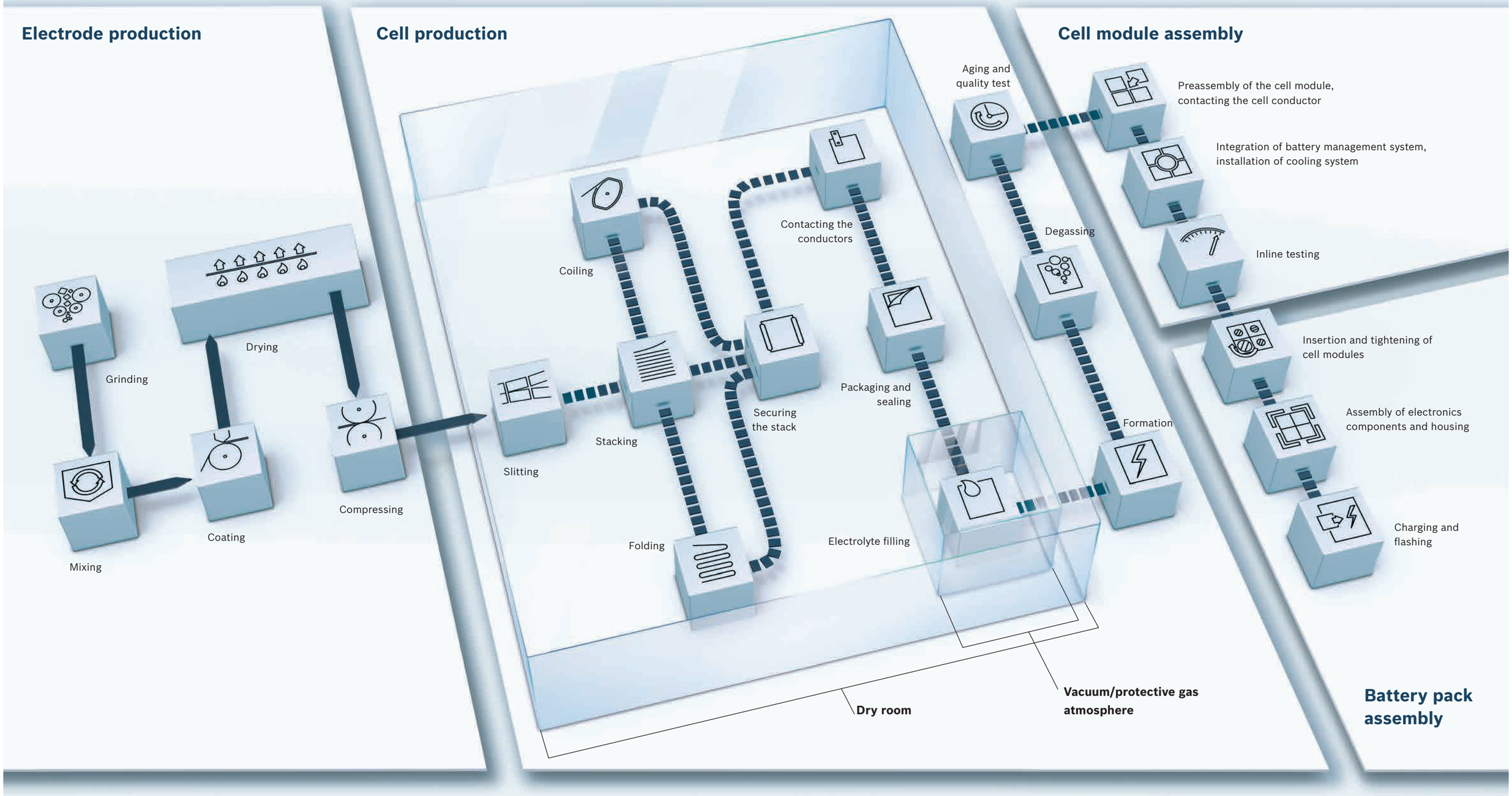
**Consistent standardization: best-in-class machine concepts with unsurpassed flexibility**

New energy storage technologies continue to develop and evolve. To implement specific requirements, you need to tap into your full productivity potential:

- Consistent cross-technology standardization
- Flexible adaptation and fast responses to changing requirements or batch sizes
- Optimum implementation of customer-specific needs

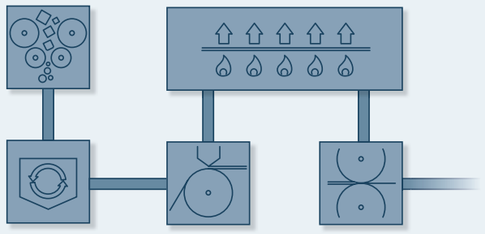
Our wealth of experience from numerous applications helps us create fast, flexible, and reliable solutions. We provide convincing and highly versatile concepts while also ensuring greater efficiency and investment security.

# Advanced technologies for all core processes

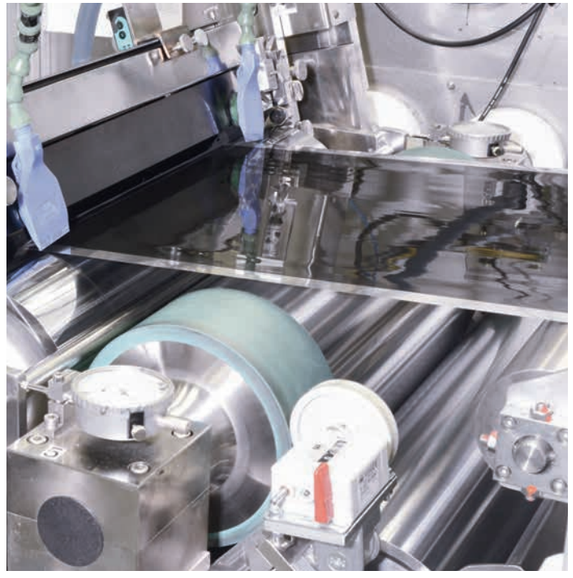


# Electrode production

## Electrode production process



**Active materials prepared according to rigorous standards**
Regardless of the cell or battery type that is produced, the production process starts with the preparation of active materials. Various components are weighed and mixed in the right ratio, ground, and then combined with solvents. During grinding, these mixtures need to be both reproducible and consistent, demonstrating the same, precisely set particle sizes. Contaminants, e.g. abrasion from machine components, cannot be permitted.
In addition, the anodes and cathodes need to be coated in separate steps to prevent cross contamination.



**Perfect interplay of solutions for the coating process**
Coating places high demands on your production system, since it has a major impact on properties, life cycle, and energy density. These criteria are essential to the performance as well as the cost efficiency of your production:

- High-speed application of fine layers with a tight tolerance and over large surfaces
- Coating on both sides in a single step, as well as solvent recovery during drying
- Continuous inline quality control and automatic film roll changeover

Solutions from Rexroth give you substantial benefits and boost your production and resource efficiency.

**High-end calenders for high-precision production**
Calenders need to operate at high speeds and with utmost precision at a range below 1 µm. Rexroth provides its own unique peripheral modules with hydraulic cylinders, which stand out thanks to their singular precision and durability:

- Complete systems, from simulations to fully automated production solutions
- Tailor-made technology functions in combination with highly accurate pressure and position controls
- Energy-efficient pressure supply via variable-speed pumps with dynamic control valves

Our solutions offer elegantly simple handling of simple handling of control units and drives, making commissioning even faster thanks to sophisticated, powerful components.

**Controller-based motion logic system**
This versatile control has the ideal design for electrical and hydraulic drives:

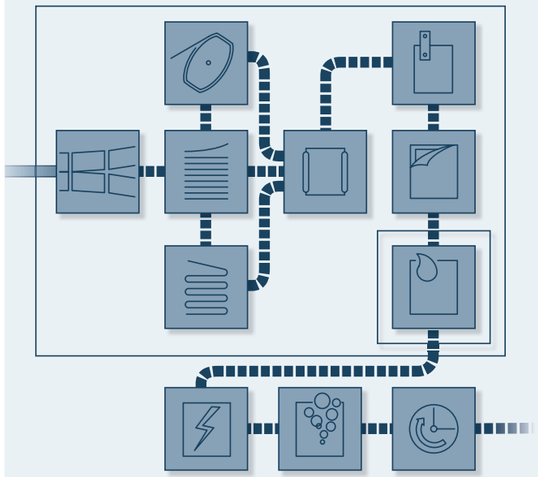
- Axis synchronization and electronic gearing for up to 64 axes via the sercos automation bus
- Interfaces: sercos, PROFIBUS, PROFINET, DeviceNet, EtherNet/IP
- Optimal control of path tension, winder, temperature, and register


**Electromechanical cylinder EMC**
Available in six different sizes, electromechanical cylinders ensure the precise adjustment of rollers:

- Precise positioning thanks to an integrated, pre-tensioned ball screw drive
- Closed system, exterior surfaces made of robust stainless steel or anodized aluminum
- High number of balls for increased load ratings

# Cell production

Cell production process



**Highly efficient production of superior cells**
Each application creates different demands for energy storage: mobile solutions require high performance; stationary solutions need to have a higher storage capacity. Cells are a crucial factor for battery performance and quality. Developing superior cells with an excellent power density is currently the biggest challenge in the market. As a specialist for automation technology, Rexroth has the necessary expertise to get your production facilities in shape for cost-efficient battery production.

**Solution-driven cell production with high process reliability**
Different production methods are employed as electrode films are processed into cell elements. From pouch cells to hard case and round cells, we always focus on finding the perfect solution:

- High dynamics and precision when separating or stacking the cathodes/anodes
- Compliance with special dry room and cleanroom requirements (humidity less than 1%, no particles larger than 10 µm) or production in a protective gas atmosphere
- Coordinated, high-precision multi-axis movements and efficient linking of processes

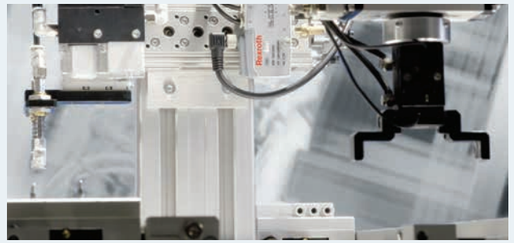
Rexroth's expertise in dry room and cleanroom production, including long-term component testing, gives you major benefits when it comes to high quality standards and reliable production processes.

**Automation of cell production for unbeatable efficiency**
Sophisticated automation solutions can take the productivity of cell production to a whole new level. With our intelligent EasyHandling solution, you benefit from standardized mechanical and electrical interfaces for fast assembly and commissioning:

- Planning, simulation, configuration, and control with convenient tools on a single platform
- User-friendly assistant for faster commissioning

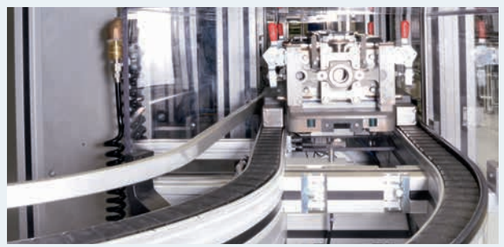
Our linear motion system caters to specific electrolyte filling requirements:

- Floating, particle-free workpiece transport
- Elimination of costly cable ducts, all electronic components outside the atmosphere chamber



**Turnkey automation with IndraMotion**
IndraMotion for Handling, the turnkey automation solution, is part of the EasyHandling system and ideal for time-optimized point-to-point motion and path-optimized linear motion:

- Easy teaching in, fast programming
- Reliable monitoring concept
- Diagnostic tool for energy-efficient operation

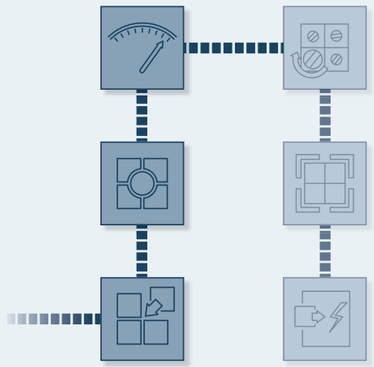


**Transfer systems in demanding environments**
Our transfer systems play a key role in ensuring smooth operation. With endurance testing and certification for dry room applications, they have stood up to countless practical challenges:

- Highly compact design
- Trouble-free functioning with humidity < 1%
- Certified for ISO class 6 cleanrooms

# Cell module assembly

## Cell module assembly process



**Cell module production based on individual requirements**
During cell module assembly, cells are placed in frames, stacked, and joined. Outgoing conductors, circuit boards for electronic battery management, and cooling elements round off a complete cell module. ESD protection requirements are extremely high.
Most assembly experts agree that automation in this field should be based on actual requirements. Especially for smaller batch sizes, manual production systems often prove to be the more economical alternative with lower investment costs. For larger quantities, more automation really pays off.

**Efficient, flexible cell module assembly with advanced systems**
Regardless of performance requirements or the cell type used, cell modules involve special production requirements:
- Avoiding damage to cells during gripping or handling, especially for variable shapes and surfaces (e.g. pouch cells)
- High flexibility in designing production lines due to dynamic, quickly evolving storage technologies

Rexroth has an extensive amount of cross-technology experience when it comes to manufacturing cell modules. This includes ultra-sensitive high-performance handling systems, as well as ergonomically designed manual workstations.

**Highly productive transport solutions with multi-faceted conveyor systems**
Transport is extremely important for a smooth workflow. The production concept determines the choice of components. With Rexroth systems, you can create just about any customized transport solution while receiving decisive benefits:
- Compact, space-saving design, high dynamics for a high throughput
- Durable, low-maintenance components with high availability and low operating costs
- Excellent suitability for ESD environments

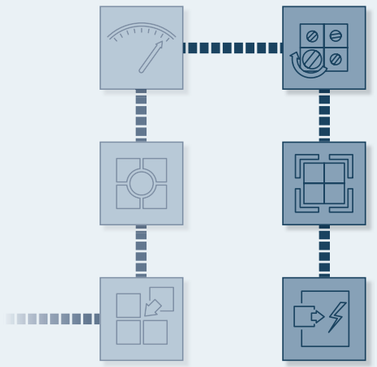
Maximum efficiency, a highly flexible system concept, and a low TCO give you a clear competitive advantage.

**MPS Manual Production Systems**
Modern production requires lean processes and ergonomic workstations. This supports the flow of production, avoids waste, and optimizes added value:
- Diverse, ESD-compliant product and parts range for virtually limitless possibilities
- Integration of lean production criteria

**MT*pro* planning software**
Software tool for planning conveyor systems or manual production systems:
- Selection of components via drag and drop for planning assembly and workstation systems
- Intelligent ManModel function for ergonomic workstation planning
- Automatic creation of parts lists to facilitate the smooth ordering of components

# Battery pack assembly

## Battery pack assembly process



**Reliable, safe solutions for battery pack production**
A battery pack consists of several cell modules and is configured for specific requirements and the desired performance. During the assembly of battery packs, in addition to reliable transport of the heavy cell and pack modules, professional tightening methods are crucial. Tightening involves significant advantages, since these reversible connections allow individual modules to be replaced in case of malfunctions. Battery packs also meet the highest requirements in terms of stability.

**Economical, safe assembly of high-quality, powerful battery packs**
Battery pack assembly is subject to the same delicate conditions as the overall process chain. Several cell modules come together to form a customized battery system – with special requirements:

- Preventing all types of short circuits
- Avoiding parasitic voltage caused by assembly
- Worker protection as the top priority
- Secure tightening for excellent battery pack quality with complete documentation of all tightening operations

Rexroth has the right tailored solution for every task, so that you can optimize your production and make it more cost-efficient.


**Meeting all requirements with specialized tightening systems**
Precise tightening technologies for all key tightening tasks in a wide variety of industries:

- From ergonomic handheld nutrunners to fully automated tightening systems
- A highly innovative and powerful handheld tightening system – the Nexo cordless nutrunner, for maximum freedom and flexibility at workstations

Electric tightening systems from Rexroth meet all important demands for any type of tightening operation: from safety-critical tightening steps that can involve danger to life and limb in case of a malfunction, to function-critical steps that can cause product failures if not correctly performed, up to non-critical tightening operations. With high-performance Rexroth tightening technology, you get reliability through and through. For maximum freedom and flexibility at your workstations.


**Special tasks – special solutions**
For worker protection and the protection of premium-quality workpieces:

- Battery assembly kits for handheld nutrunners for flexible and safe assembly, also available as retrofits
- Special, insulated outputs protect workers, tools, and surroundings from battery voltage

**Transfer system for heavy loads**
Modular heavy-duty TS5 conveyor. Especially suitable as a roller conveyor for battery pack assembly due to its high load carrying capacity:

- Workpieces are transported directly on rollers or a workpiece pallet
- Different curves, diverters, and positioning elements enable highly individualized layouts

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