

**Bosch Rexroth**

**Factory Automation**

**Battery Manufacturing**



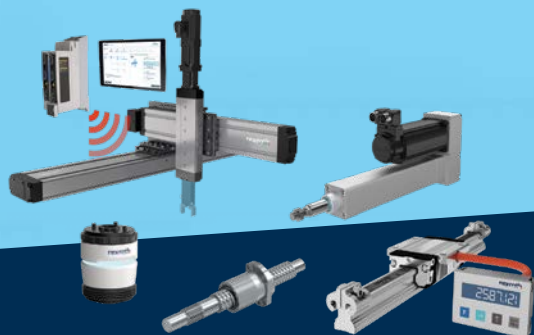
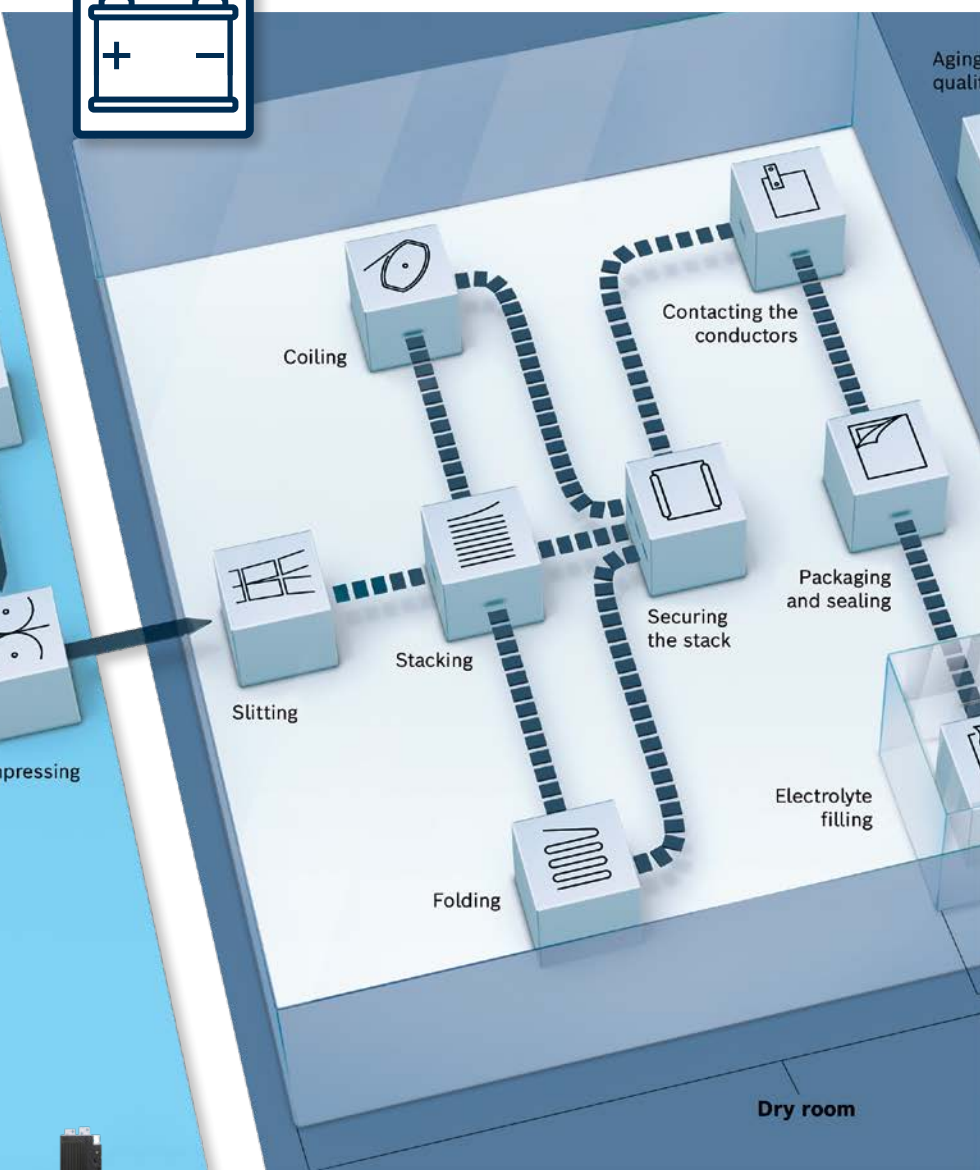
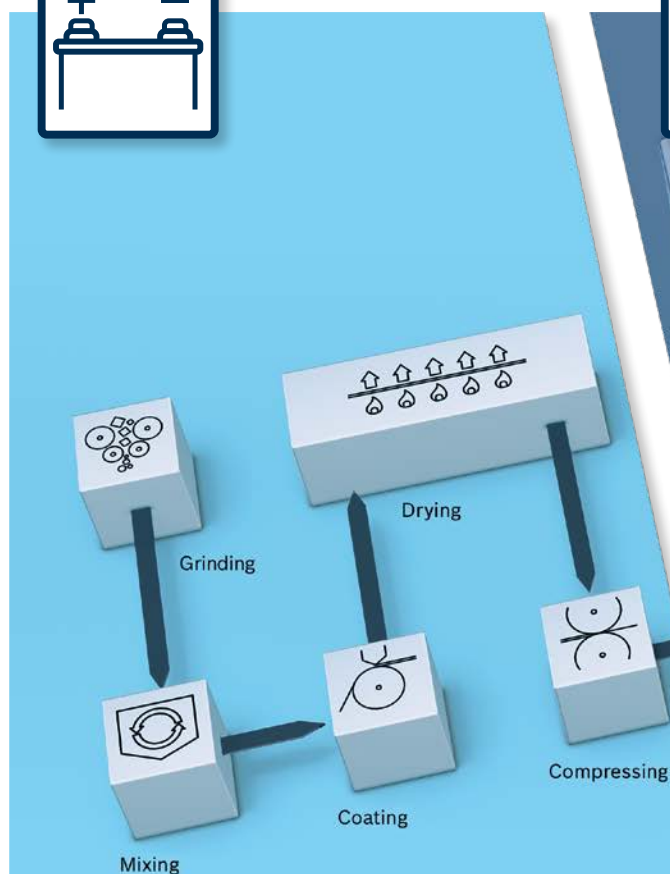
# Advanced Technologies for all core processes



## Electrode Production



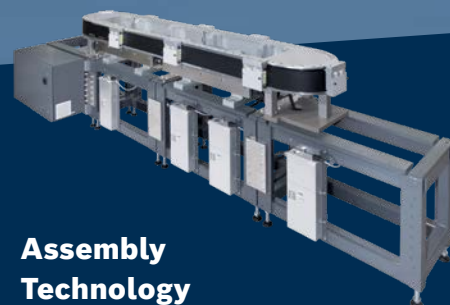
## Cell Production



**Linear Motion Technology**



**Electric Drive and Control Technology**



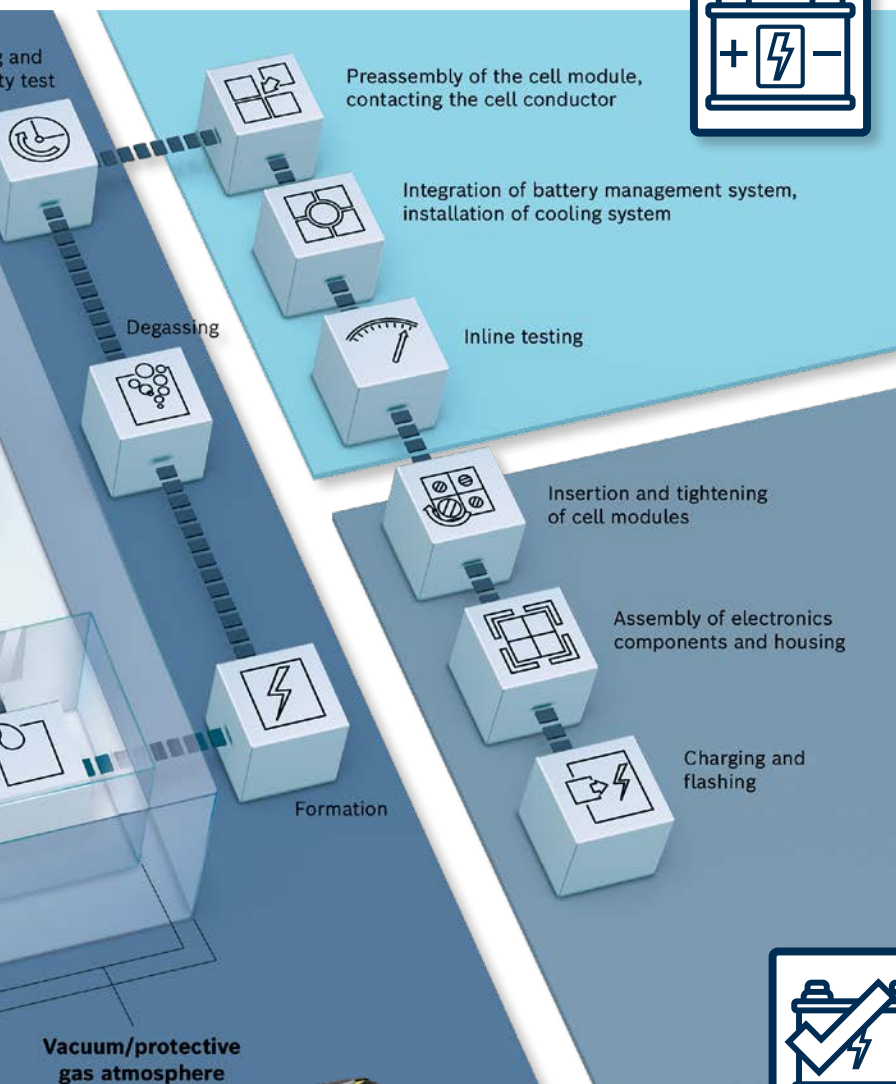
**Assembly Technology**



# Custom solutions

## for your battery technology

### Battery Assembly



### WHY REXROTH?

Bosch Rexroth is a globally established provider of automation solutions for battery production in various formats and technologies. We offer cross-technology solutions for electrode production, cell production, battery module and pack assembly stations.

- We are your one-stop shop for products and solutions
- We have extensive knowledge of battery manufacturing processes
- We offer solutions – not just a box of parts
- We are a large organization with a global footprint – offering project and service support worldwide



### Battery Testing



**Autonomous Mobile Robotics**



**Collaborative Robots**



**Tightening and Joining Technology**



**Resistance Welding Technology**

# Electrode Production



Regardless of the cell or battery type that is manufactured, 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 the grinding process, 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.

## FEATURES / BENEFITS

Bosch Rexroth offers expertise in cross-technology automation solutions for battery manufacturing. We are a strong partner with extensive technological experience in implementing highly efficient production systems for web handling and coating processes.

- Most comprehensive motion library for all types of machines
- Built-in motion library for roll-to-roll coating processes
- Fast system configuration and ease of programming in common languages
- Full connectivity in IoT and to customer MES
- Full machine and operator protection with functional safety and ease of error recovery
- Products and solutions for clean room and dry room environments

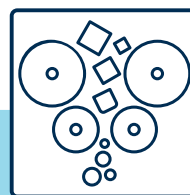
## Automation Solutions

### 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:

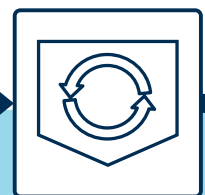
- High-speed application of fine layers with a tight tolerance and over large surfaces
- Coating on both sides in a single step, as well as solvent recovery during drying

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



### Grinding

- Synchronous motors for explosive environments
- Precise roller speed control and synchronization with ctrlX DRIVE
- Accurate roller pressure control with EMC rod style actuators



### Mixing

- Synchronous motors for explosive environments
- ctrlX CORE controls for precise velocity control

• Pr  
co  
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# Active materials prepared

## according to rigorous standards



### High-end calenders for high-precision production

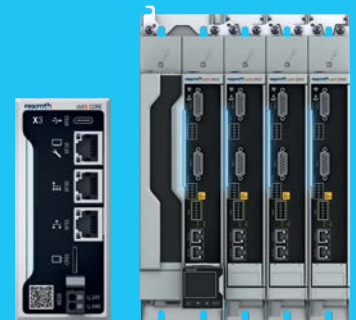
Calenders need to operate at high speeds and with utmost precision at a range below 1  $\mu\text{m}$ . Bosch Rexroth provides its own unique peripheral modules with electric or hydraulic cylinders, which stand out thanks to their singular precision and durability:

- 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

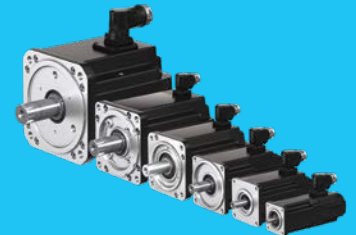
Our solutions offer simple handling of control units and drives, making commissioning faster thanks to ease of programming in industry standard languages.

### Product features / benefits:

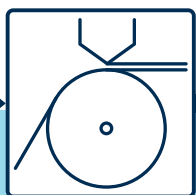
- Closed-loop sag and loop control for precise material feed to eliminate web breakage and minimize waste
- On-the-fly diameter calculation
- Electronic gearing and camming
- High-speed position latch at the servo drive level for most precise position capture
- High-speed multi-axis synchronization for web speed and position alignment
- Industrial standard network communication
- Ease of programming in most common languages in use today



ctrlX AUTOMATION

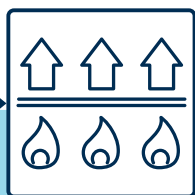


Servo Motors



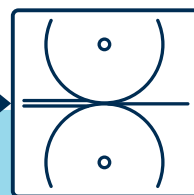
Coating

Precise roller speed control with ctrlX DRIVE  
Accurate roller pressure control with EMC rod style actuators  
Exact control of complex processes via an integrated pre-tensioned roll screw drive



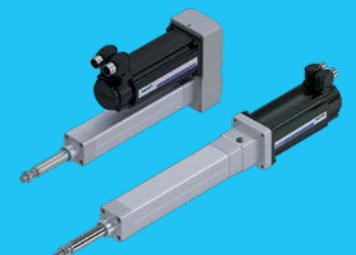
Drying

- Corrosion resistance for operation in dry room environments
- Special mechanical and electrical options for operation in raised temperature environments



Compressing

- Precise pressure control with EMC rod-type actuators
- Seamless integration with Rexroth motion controllers
- Fast integration of force feedback
- Accurate roller speed with built-in multi-axis synchronization and tight velocity loops



Electromechanical Cylinders

# Cell Production



## FEATURES / BENEFITS

- High throughput
- Flexibility in system scalability
- Compact material transfer solutions
- Reduced machine footprint
- Rapid design development
- High dynamics and precision when stacking the cathodes and anodes
- Compliance with special dry room and clean room requirements or production in a protective gas atmosphere
- Advanced tuning algorithms
- Cabinet-free drive technology
- Motor-integrated drives:
  - Reduced cabinet cabling
- Rapid designing with LinSelect and MTPro design software
- Data tracking for predictive maintenance
- Final assembly tolerance requirements within  $\pm 50 \mu\text{m}$

**Each cell technology poses its own manufacturing challenges. Whether cylindrical, pouch, prismatic or solid state; cells are a crucial factor for battery design, performance and quality. As an automation technology specialist, Bosch Rexroth has the necessary expertise to help optimize your cell production for cost, quality and throughput.**

## Automation Solutions

### High speed cell transport systems –

#### 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 cylindrical 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 clean room requirements (humidity less than 1%, no particles larger than  $10 \mu\text{m}$ ) or production in a protective gas atmosphere
- Coordinated, high-precision multi-axis movements and efficient linking of processes

Bosch Rexroth's expertise in dry room and clean room production, including long-term component testing, affords benefits when it comes to high quality standards and reliable production processes. Cell manufacturing calls for fast and efficient material transport solutions. Rexroth's VarioFlow *plus* offers a powerful and versatile conveyor system highly suited for high density automation and tight spacial constraints. It is a flexible, modular plastic chain conveyor, with the design versatility to move high-volume products horizontally, vertically, and around obstacles.

Rexroth's ActiveMover is ideally suited for high speed and precision assembly applications, such as battery cell assembly. Cycle times are reduced due to magnetically coupled linear motor motion and elimination of extra indexing. For applications with payloads greater than 10kg, Bosch Rexroth offers the magnetically propelled pallet-based FTS transport system, which allows for high speed and high precision product transport and positioning within automated process cells and beyond.

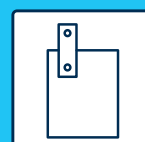
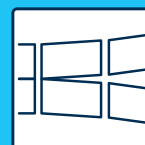




# Highly efficient production of superior cells

## VarioFlow plus Conveyors

- Fast and efficient cell transport within process stations and between machines
- Tight turn radius for minimized tool footprint
- Product can be transported on pallets or directly on the conveyor media
- Configurable for utmost design flexibility
- Chain width: 65, 90, 120, 160, 240, 320 mm
- Speeds up to 100 m/min
- Low noise < 70 dbA



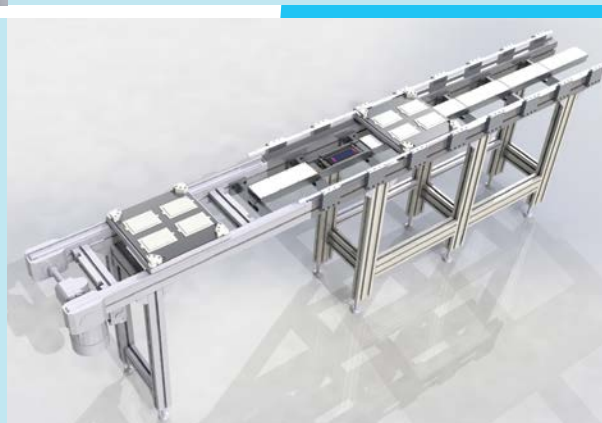
## ActiveMover Transfer System

- Highly dynamic and low-vibration transport
- Positioning accuracy  $\pm 0.01$  mm
- Speeds up to 150 m/min
- Acceleration of 40 m/s<sup>2</sup> with 1 kg load, 10 m/s<sup>2</sup> with 10 kg payload
- Load per workpiece pallet of up to 10 kg
- Workpiece pallet width of 165 mm to 500 mm
- Asynchronous and synchronous operation
- Open interface: Ethernet/IP, PROFINET, EtherCAT, Sercos, etc.

## Flexible Transport System Pallet Boost

Highly dynamic magnetically propelled transfer system for high throughput machines and assembly lines

- Synchronous and asynchronous bi-direction transfer
- Can be used with standard TSplus modules to create a complete loop or as a stand-alone section
- Precise motion profile and stopping control
- Acceleration max. 30 m/s<sup>2</sup>
- Speed max. 5 m/s
- Positioning accuracy up to  $\pm 20$   $\mu$ m
- Pallet size from 160 x 160 mm to 640 x 640 mm
- Maximum Load: 40kg/pallet

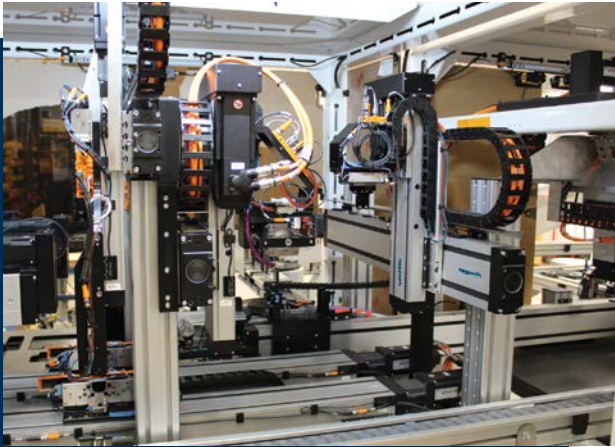


## Success Story

**High throughput battery cell production: How DWFritz and Bosch Rexroth created a custom automation line in record time.**

Read the story [here](#).

# Module Assembly



**Today's battery packs require high precision cell positioning. 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 need to meet the highest requirements in terms of stability and stiffness. That's where Rexroth's resistance welding experience comes in.**

## FEATURES / BENEFITS

**Today's high speed module assembly systems require fast and precise motion and rapid material transfer.**

- **Highly precise linear modules for dynamic movement of cells allowing high throughput**
- **High-speed material transport conveyance systems**
- **Compact, space-saving module design affords high density automation**
- **ESD compatibility**
- **Durable, low-maintenance components with high availability and low operating costs**



### Resistance Welding Systems

- Modular system includes advanced welding controls, either AC or MFDC inverters, and control software and interfaces for all popular fieldbuses.
- Adaptive Control for high-quality welds
- Weld Spot Analytics (WSA) software solution that helps welding engineers make faster, more accurate decisions, and increase weld quality while avoiding inefficiencies and reducing waste
- Process reliability, flexibility, and ease of use
- Proven to increase process reliability, reduce rework costs and deliver consistent weld quality in high-throughput manufacturing operations.



### Manual Production Systems

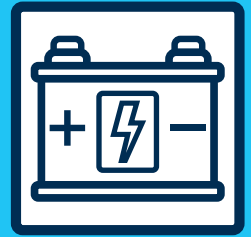


- Ergonomic, purpose-designed manual workstations utilizing the latest advancements in i4.0 technology
- Easily configured using the intuitive MTPro planning software
- Flow racks, carts, and other manual line elements optimized for efficiency
- ESD compatible
- ActiveCockpit interactive communication platform: real-time production data processing and visualization
- An intuitive user interface instantly displays process deviations on site productivity



# Reliable, safe solutions

## for battery pack production

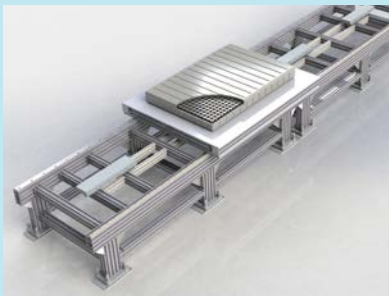
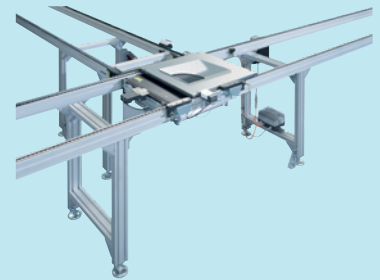


### Linear Modules and Cartesian Systems

- Pre-configured components reduce engineering, assembly and start-up
- LinSelect system configurator for quick BOM and CAD model generation
- Ballscrew and belt-driven modules
- High stiffness and system dynamics
- Repeatable to  $\pm 0.05$  mm
- Dry room compatibility

### TS Series Transfer Systems

- Palletized assembly conveyors
- MTPro software for rapid system design, configuration, CAD model, and BOM generation
- Standard pallet sizes from 80x80mm to 1.2mx1.2m
- Custom pallet compatible
- Max. payload weight: 400kg
- Dry room compatible to  $<1\%$  RH
- Clean room compatible to ISO 6
- ESD compatibility



### Flexible Transport System

- Heavy duty magnetically propelled Flexible Transport System
- Product weight: 1000kg+
- Pallet size: up to 1.5m x 2.8m
- Maximum speed: 5 m/s
- Maximum acceleration:  $10\text{m/s}^2$
- Pallet to Pallet position accuracy:  $\pm 0.02$  mm
- In-line, track, and over/under line configuration possible
- Takes over positioning tasks, allowing simpler machine mechanics in module production

### Smart Function Kit for Handling

- Two and three axis configurations
- Higher stiffness, dynamics, and accuracy than a 6-axis robot
- Product weight up to 100kg
- Zero programming, open interfaces
- Seamless integration with the Flexible Transport System
- Fast selection, system configuration & servo parametrization
- Ships fully assembled
- Design & Commissioning effort cut by 85%



### Nexo wireless intelligent nutrunner

- Cordless DC technology with integrated torque/angle sensors provide safety-critical rated performance
- Available in Pistol, right angle, and custom output drive configurations up to 100Nm
- Isolated output options provide maximum safety when working around battery voltages up to 800V
- Analytics allow detection of manufacturing issues such as defective studs, grounds, lugs, taps, etc.

# End of Line Testing (EOL)

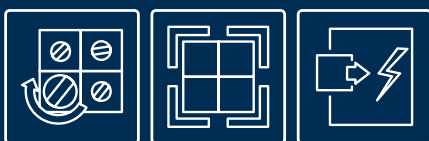


**End-of-line battery testing systems must take into consideration the challenges associated with high output mass production of vehicles. A plant producing 50 EVs per hour would have a new battery pack to test every 72 seconds. Battery packs are complex devices, that's why Rexroth EOL test systems combine advanced testing software with the latest generation of high performance industrial inverter drives to provide safe, controlled and rapidly delivered DC power to supply/ remove the correct amount of power to battery packs according to the testing program's requirements.**

## SOLUTION SET BATTERY CYCLING / TEST

End-of-line test stands with the scalable drive system IndraDrive ML and fastPLC system ILC

- Effective use of common hardware for power supply, drive inverter, and DC/DC Converter
- Efficient line regeneration and lowest harmonics
- Scalable DC/DC converters
  - Up to 1000V DC, and high power, e.g. 500kW
  - Lowest ripple of DC voltage and current
- Small footprint, cabinet size, and system weight
- Future-proof open connectivity (PROFINET, EtherCAT, Sercos, Ethernet/IP, Sercos, Modbus TCP, Ethernet, OPC-UA, LabView, Simulink, Java and more.)



### Modular power conversion

- Energy regeneration
- Energy sharing DC-bus
- High bandwidth DC battery simulation
- < 0.1% current ripple
- Common power hardware

### Global AC Grid Supply

- Lowest harmonics
- IEEE519/EN61800-3 prep.
- 400-690V 50/60Hz

### Open Standard Control

- Integrated safety
- High performance 250us

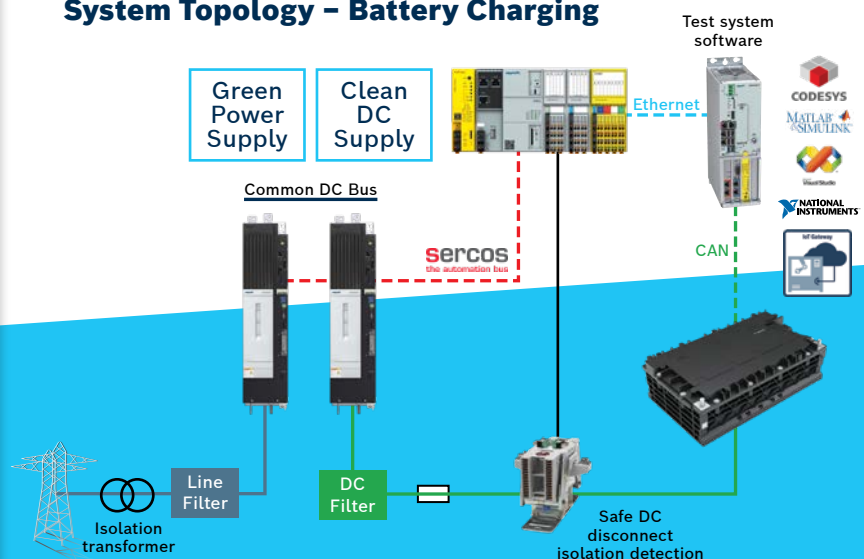
### Robust CAN CRio Battery Interface

- CAN battery management system communication
- Road simulation
- Battery charge/ discharge

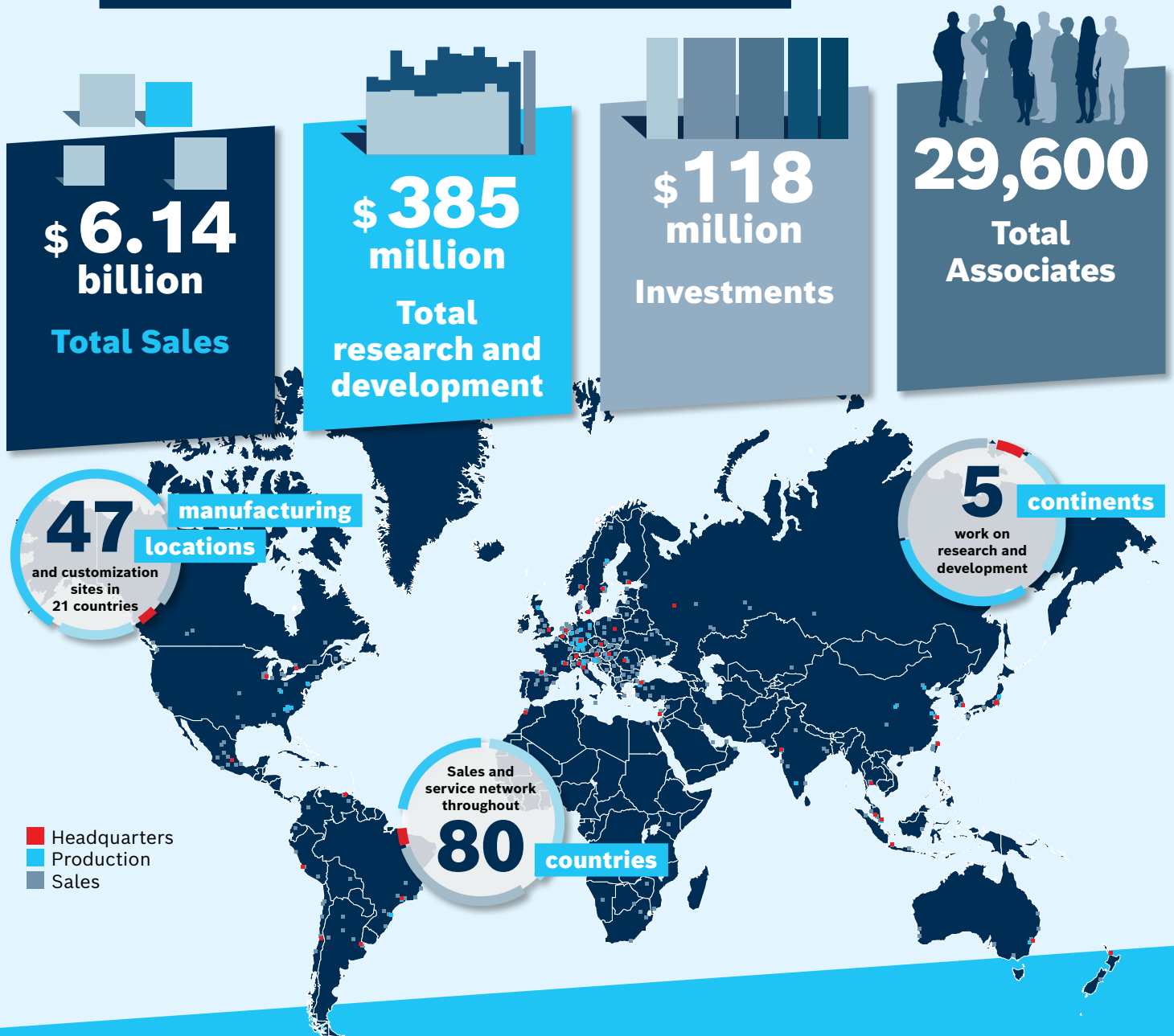
### Safe operation

- Safe DC disconnect
- Ground isolated DC battery

## System Topology – Battery Charging



# Bosch Rexroth – Your Global Partner



Bosch Rexroth combines the ability to link global resources with local support – thanks to global product platforms, local added value, and the ability to coordinate projects spanning borders and to bundle the necessary resources. We are present in over 80 countries, guaranteeing competent advice and support, as well as, fast service anywhere in the world. Bosch Rexroth develops and produces locally adapted products based on global engineering teams in Europe, the Americas, and Asia.

With the services we offer, we work alongside machinery manufacturers and end users around the world and ensure the success of international projects.



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