

EXPERIENCE MOBILITY

# BATTERY TECHNOLOGY.

SUSTAINABLE SOLUTIONS – AS SERIES.



SYSTEM PARTNER. PROBLEM SOLVER. PIONEER.

# SHAPING THE FUTURE. WITH ELRINGKLINGER.

For us, system expertise means being a pioneer, creating freedom and reaching goals faster. With our portfolio, we offer groundbreaking solutions for all vehicles, whether traditional, hybrid or pure electric.

Proximity to the customer, developing visions, overcoming challenges and driving forward innovations: Those are our key strengths, that's what has made us what we are today.

YEARS LEADING THE WAY



# 140

Nothing can replace experience combined with innovative spirit. ElringKlinger has plenty of both. In 1879, Paul Lechler founded a trading company for technical products, which would later become ElringKlinger AG. Today, we are a global player offering future-proof solutions for all drive types in all product areas. We also demonstrate our strengths in other industrial sectors. Our customers benefit from ElringKlinger's combined materials, design, development and manufacturing expertise. Thinking ahead, developing solutions, being the first to break new ground, taking responsibility. That's what sets us apart – for more than 140 years.

# 4

STRATEGIC  
KEY AREAS

Alternative drive technologies, lightweight engineering concepts, new forms of mobility, sustainability and climate protection: The transformation process in the automotive industry is in full swing. The agenda for the future is clear. We are also working every day to play our part and push the limits of what is possible. We are focusing on four strategic fields: Electromobility, lightweight construction for all drive types, traditional mobility and non-automotive. Together with our customers, we are already finding answers to the questions of the future. And successfully driving forward innovations.

# 9,500

EMPLOYEES AS PARTNERS

For our customers, we are a strong and reliable development partner and series supplier with unique expertise. We are a pioneer and companion. From the idea to the finished product. Whether electromobility, lightweight engineering, gasket and shielding technology, tool technology or engineering services – ElringKlinger impresses with the highest quality, reliability and performance. Around 9,500 employees are committed to achieving this at more than 40 sites worldwide.

## BATTERY TECHNOLOGY

# ELRINGKLINGER – PARTNER WITH EXTENSIVE EXPERTISE.

The automotive industry is changing, with a focus on sustainable mobility and alternative drive technologies. ElringKlinger laid the foundation early on, is helping to shape these topics significantly – and is taking you along into the future.

## DEVELOPMENT AND TESTING CENTER FOR THE MOBILITY OF THE FUTURE

ElringKlinger has been researching alternative drive technologies for around 20 years. We bundle research and development in all aspects of battery technology at our sites in Dettingen/Erms, Neuffen and Thale in Germany. And we are working on further innovations for the mobility of today and the future. We offer the relevant testing and safety equipment for this, such as cell tests, module tests or components safeguards to test the products in all respects.

This enables us to provide the optimal conditions for embarking on new paths and to achieve your goals faster.

Other automotive manufacturers and suppliers use the extensive expertise of ElringKlinger and implement their developments and tests in cooperation with us. Reliable, economical and innovative.

Location Dettingen/Erms, Germany



Location Neuffen, Germany



Location Thale, Germany



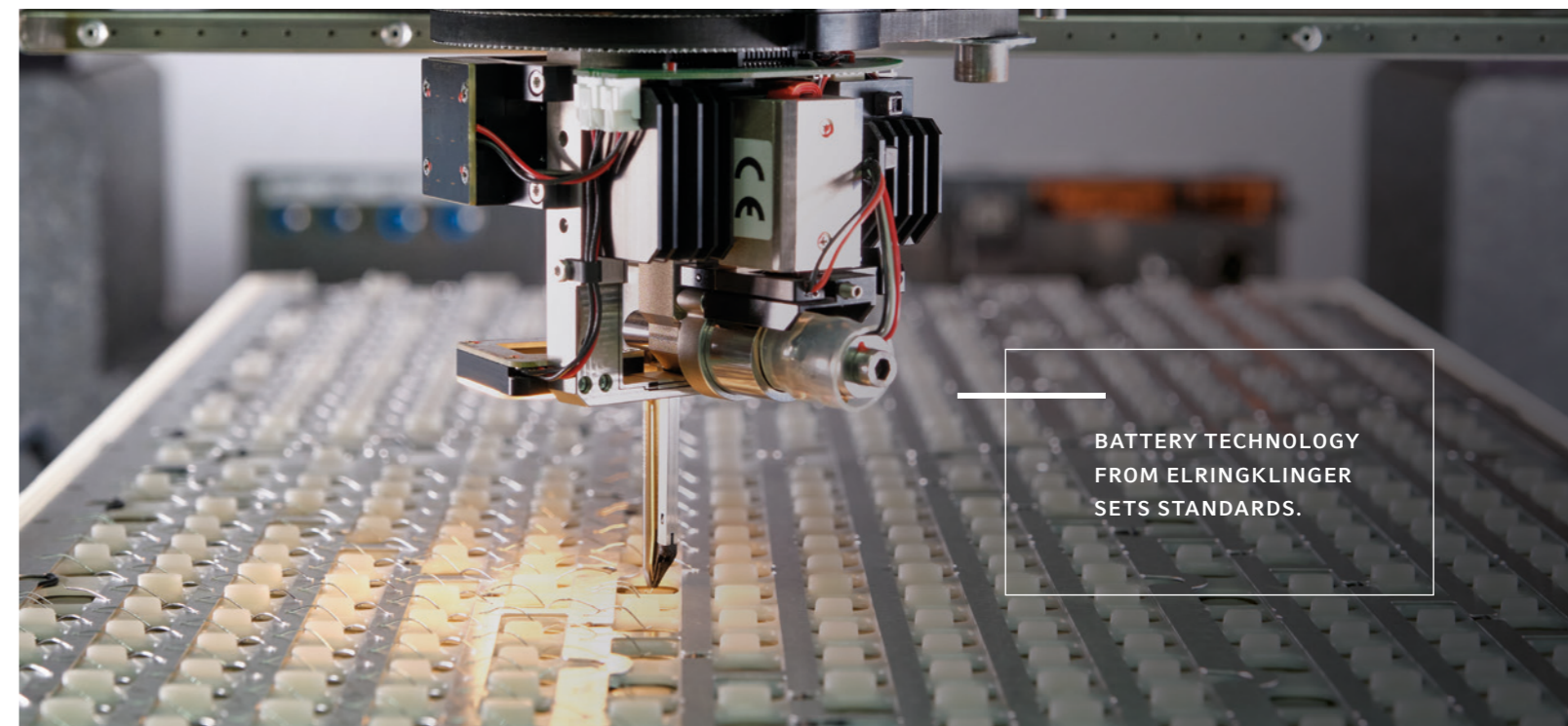
## BATTERY TECHNOLOGY

# ALWAYS AT FULL POWER: OUR INTERNATIONAL R&D TEAM

## ELRINGKLINGER PRODUCES INNOVATIVE COMPONENTS FOR SUSTAINABLE MOBILITY

We manufacture lithium-ion battery modules in economical series production as well as cell contacting systems and cell housings. We also develop and manufacture complete battery systems.

Our mission: To drive forward innovations, set standards and to help shape the technological transition with high-performance and high-quality product solutions. For sustainable mobility. Worldwide.



BATTERY TECHNOLOGY  
FROM ELRINGKLINGER  
SETS STANDARDS.



CORE EXPERTISE

# ELRINGKLINGER – YOUR PARTNER IN THE FIELD OF BATTERY TECHNOLOGY.

## PRODUCT CREATION PROCESS “EVERYTHING FROM A SINGLE SOURCE”

ElringKlinger offers everything from a single source in the field of battery technology. From development and prototype production, testing through to series production. And from individual components like the cell cover through to the complete battery system. Short development cycles, the complex interaction of the individual components, and exacting demands in terms of both cost-effectiveness and sustainability, all make a comprehensive approach essential. This is the only way to create intelligent solutions at the highest technological level.

PRESSURE EQUALIZING UNIT & BURST UNIT



BATTERY SYSTEM



BATTERY MANAGEMENT SYSTEM



BATTERY MODULE



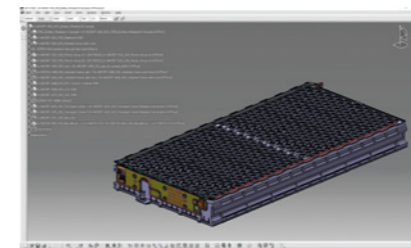
CELL CONTACTING SYSTEM



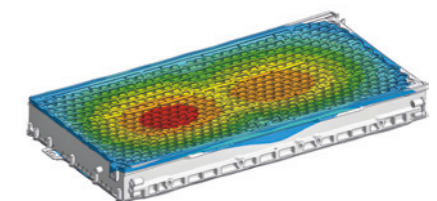
CELL HOUSINGS



DESIGN



SIMULATION



PROTOTYPE PRODUCTION



TESTING



INDUSTRIALIZATION



SERIES PRODUCTION



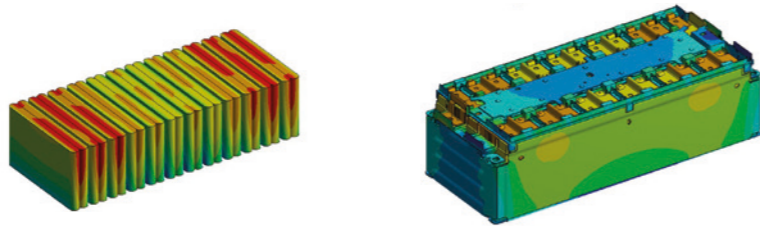
PRODUCT EXPERTISE

DEVELOPMENT EXPERTISE



### SIMULATION FOR OPTIMIZED DEVELOPMENT

ElringKlinger offers extensive expertise in all aspects of the product creation process in the field of battery technology. Simulation enables quick and clear evaluation of development states. In the field of mechanics, for example, shock and vibration analyses can be carried out in accordance with all common standards. Our electrothermal cell, module and battery system models offer a valid performance and aging prognosis in the early stages of development. Extensive experience in the simulation of propagation and thermal runaway with experimental validation complete the CAE expertise for the entire virtual design evaluation.



### TESTING OPTIONS FOR THE MOBILITY OF THE FUTURE

For safeguarding the battery development, ElringKlinger relies on both in-house expertise and on a network of highly qualified testing service providers (e.g. TÜV Süd, ZSW Ulm, hofer powertrain).

The test capacities in the field of battery storage, as well as module, cell and component testing, were expanded for the continuous expansion of the e-mobility portfolio. In addition to high-tech devices for analytics (e.g. glove box, X-ray and scanning electron microscope) Shaker, Hardware-In-The-Loop systems and test benches for cell and battery systems in different versions are available.

ElringKlinger tests and validates battery systems, modules, cells and components over an area of 2,000 m<sup>2</sup>. The expertise ranges from mechanical tests through to electrical and electrochemical tests. Testing options are in place to meet all relevant test guidelines and standards (such as LV124, LV123, ECE R100).

### HARDWARE-IN-THE-LOOP

Our HiL test bench enables us to extensively test the control software of our battery management system (BMS) and to develop it further. The control of the entire system or, optionally, individual system modules, is validated under simulated conditions (e.g. specific battery voltages/currents, temperatures, etc.). The modular design of the test bench enables most components of the BMS to be inserted either simulated or in real life to depict a wide range of scenarios that are almost impossible to replicate in the closed system.

The simulated environment enables tests to be carried out automatically and efficiently on the HiL test bench. A test setup can thus be carried out fully automatically with several hundred test cases within a week.



**EXTENSIVE TEST OPTIONS ARE AVAILABLE AT THE LOCATION IN NEUFFEN, GERMANY.**



### COMPONENT TESTING

At the site in Neuffen, complete battery systems including control unit for use in the vehicle and a wide range of battery components (e.g. pressure equalizing units, CSC, cell contacting systems, housings and many more) are developed and tested to series maturity. Suitable testing equipment for electrical, mechanical and chemical testing is available for this.

### BATTERY CELL AND MODULE TESTING

The cell is the smallest unit and also the core of a battery system. Without exact knowledge of the properties of Li-ion cells, it is impossible to develop and qualify systems for use in the vehicle. In addition to determining the service life and performance, ElringKlinger can also replicate the installation situation in the module when testing the cell via specially developed clamping equipment. All common cell formats can be tested on test benches from 75 A to 600 A under different temperature influences.

Despite alternative ideas like the so-called Cell-To-Pack design, the use of battery modules as a compact intermediate unit is still state-of-the-art. ElringKlinger uses the latest technology and can test modules with up to 1200 A and 90 V.

### BATTERY SYSTEM TESTING

It should be highlighted that installation in a complete system is replicated as realistically as possible. This means that, in addition to the operation of cooling circuits, the communication with the battery management system (BMS) via isoSPI or CAN can also be simulated.

For maximum flexibility, ElringKlinger uses a modular setup on its test benches, consisting of accessible climate chambers, high-performance cooling units and loading/unloading units with flexible connection. Battery systems with up to 500 kW at 1000 V can currently be tested. But the test benches are designed to enable much higher performances of up to one megawatt. We place a particular focus on safety here, which is why all test benches for testing Li-ion batteries are equipped with sophisticated safety systems, such as a modern water spray extinguishing system.



## PROTOTYPE SHOP

In the prototype shop spanning over 1,500 m<sup>2</sup>, new technologies, processes and products are developed. This paves the way for a successful industrialization and series production.

The different products such as battery modules, battery storages, cell contacting systems and cell covers are produced here in close cooperation with the development departments.

ElringKlinger can offer battery components and systems tailored precisely to the requirements of the customer.

Flexible production systems enable production, assembly and testing of individual components tailored to the relevant products, right through to small-batch production. Processes such as laser welding, ultrasonic welding, bonding and much more are adapted to the designs of the battery storage, battery modules, cell contacting systems and cell covers. At the end of the process chain, the prototypes and small-batch parts are subjected to a 100 % End-of-Line test.

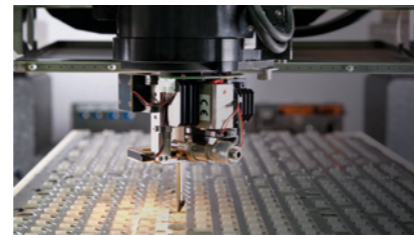
## CELL TEST



## LASER WELDING PROCESS



## BONDING



## END-OF-LINE TEST



## GOOD TO KNOW

Short development cycles, the complex interaction of the individual components, and exacting demands in terms of both cost-effectiveness and sustainability, all make a comprehensive approach essential. This is the only way to create intelligent solutions at the highest technological level.

## BATTERY SYSTEMS

# REACHING THE GOAL SYSTEMATICALLY AND SAFELY.

Innovative complete solutions where intelligence in the form of a battery management system is combined with longstanding experience and expertise in component production: The ElringKlinger battery systems.

At the heart is our battery management system with intelligent control and monitoring of current and voltage, as well as sophisticated thermal management and integrated safety equipment. The ElringKlinger complete system embodies our successful development from pure component manufacturer and battery module manufacturer through to system provider.

## MORE THAN JUST THE SUM OF ALL PARTS

ElringKlinger is a "full service supplier": We can offer the customer everything from the component and assemblies, to battery module and battery system.

The current market situation requires a high level of flexibility in the field of electric mobility. ElringKlinger offers standardized components and systems here in the 400 V and 800 V system voltage range.

In the current battery systems, ElringKlinger relies on round cells in format 21700 and prismatic cells. ElringKlinger will also use pouch cells in future battery systems.

EK standard storage 35 kWh  
available in 400 V und 800 V



EK standard storage 54 kWh 400 V



EK round cell storage (21700) 63 kWh 400 V



## ALWAYS THE RIGHT SOLUTION

Due to the ever decreasing "Time-to-Market" times and the resulting shortened development cycles at the customer, we offer prototype solutions available at short notice. With these available solutions, the customer can gain initial experiences on test benches or test tracks.

Using standardized components, we develop project-specific systems that are tailored to the relevant customer requirements.

Even if standardized components are not used, ElringKlinger is able to develop, test, industrialize and supply battery systems tailored to the specific customer requirements.



## GOOD TO KNOW

The ElringKlinger battery systems can be configured individually to your specific requirements. Or you can rely on an ElringKlinger standard solution. Available for automotive and non-automotive applications.

## PROTOTYPE WITH MILLING HOUSING





## BATTERY MODULES

# RELIABLY AND FLEXIBLY INTO THE FUTURE.

ElringKlinger offers different battery modules. Manufacturing these according to the automotive standard ensures performance and reliability.

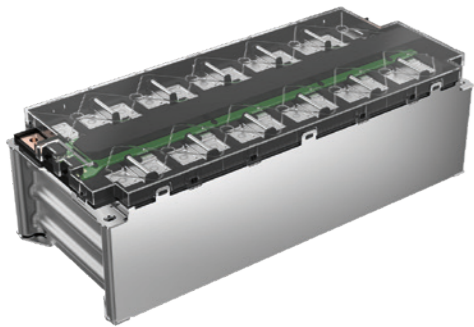
## BATTERY MODULES

Battery modules from ElringKlinger support the customer with the quicker implementation of an energy storage concept. Modules based on prismatic and cylindrical cells are available that can address a wide range of different requirements. The modules are tested for safety and compatibility with standard tests like UN38.3 and LV123 in extensive test runs.

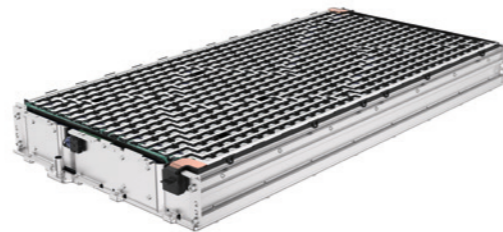
Depending on the customer requirements, the modules can be equipped with integrated monitoring electronics based on an iso-SPI.

**Module based on prismatic cells**

Cell format: PHEV2, standard and special formats possible  
Module voltage: 48 V  
System voltage: up to 800 V

**Module based on cylindrical cells**

Cell format: 21700  
Module voltage: 48 V; 60 V  
System voltage: up to 400 V



## INNOVATIVE BATTERY COMPONENTS

# PERFORMANCE AND RELIABILITY EX WORKS.

ElringKlinger is optimally equipped to meet your requirements with its component know-how in the field of battery technology. The portfolio includes cell housings and covers, cell contacting systems and pressure equalizing unit, as well as intelligent battery management systems. Connection technology from a single source – the basis for ElringKlinger to provide the suitable solutions for complete systems quickly and efficiently.

## CELL CONTACTING SYSTEMS

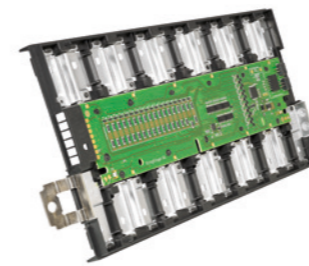
Cell contacting systems from ElringKlinger for Lithium-ion batteries in different expansion stages are tailored precisely to the relevant customer requirements and can be set up and welded directly on the cell cluster.

They consist of a plastic carrier frame that holds the cell connectors and ensures installation capability in all tolerance positions.

The required voltage and temperature sensor technology is already installed in the systems. The monitoring electronics (CSC) itself can also be integrated. Automotive plug systems or screw connectors can be used for the electrical connection outside.

**Cell contacting system for prismatic cells**

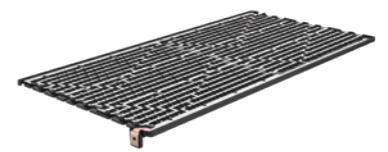
Signal carrier: PCB  
Integrated monitoring electronics available

**Cell contacting system for prismatic cells**

Signal carrier: FPC  
Integrated monitoring electronics available

**Cell contacting system for cylindrical cells**

Signal carrier: Bond  
Integrated monitoring electronics





## CELL HOUSINGS

Prismatic cell



Hardcase cell housings for use in traction batteries must fulfill the following key requirements: low electrical resistance, safe separation from active material and the environment, as well as maximum reliability of the safety equipment. ElringKlinger can rely on the expertise as a development partner and series supplier to the international automotive industry in the development and production of these components. Extensive know-how in gasket and forming technology, as well as joining processes enables a long service life of the cell to be achieved, while optimizing the high current capability for the new generation of traction batteries.

Round cell



An innovative terminal implementation enables optimized manufacturing processes and removes the need for a traditional elastomer gasket. The continuous further development of the safety elements for overpressure, excessive temperature and excessive current provides an outstanding level of safety even at cell level. The new ElringKlinger design can be adapted to all prismatic and cylindrical cell formats.

ElringKlinger is a member of the second battery IPCEI project entitled "European Battery Innovation – EuBatIn", in which a sustainable European battery value chain is being established. The development and industrialization of innovative battery cell housing components is ElringKlinger's focus in the project. The novel cell cover design makes it possible to reduce the number and complexity of components as well as the use of energy-intensive raw materials such as aluminum and copper. ElringKlinger's innovative concept makes it possible to save up to a quarter of the components. The resultant reduction in manufacturing effort and material requirements means that the carbon footprint for this product can be cut by around 40 percent.

### CELL HOUSING FOR PRISMATIC CELLS



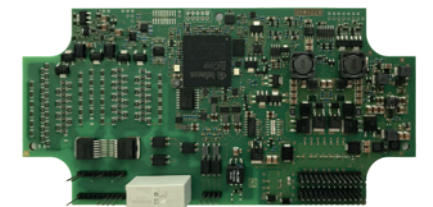
## BATTERY MANAGEMENT SYSTEM

The battery management system (BMS) from ElringKlinger is made up of the battery management unit (BMU), current measurement device and cell sensor circuit (CSC). We can design and produce CSCs for different cell formats and configurations.

The BMU sets itself apart in particular with its master-slave capability. This enables up to eight battery packs to be connected to form a system. The central control unit of the vehicle only communicates with one BMU. The broad parameterization enables the BMU to be adapted flexibly to the customer wishes.

The BMU is developed in accordance with ISO26262 and ensures that the battery storage is intrinsically safe. The software also provides standard information such as State-of-Charge (SOC), State-of-Health (SOH), capacity, internal resistance and more.

Battery management system



## PRESSURE EQUALIZING UNIT AND BURST UNIT

The storage casing must be able to equalize various pressure differences between the inside of the storage and its surroundings. These differences occur, for example, when going up or down hill, due to temperature differences or during air transport of battery modules or electric vehicles in air freight chambers without pressure equalization.

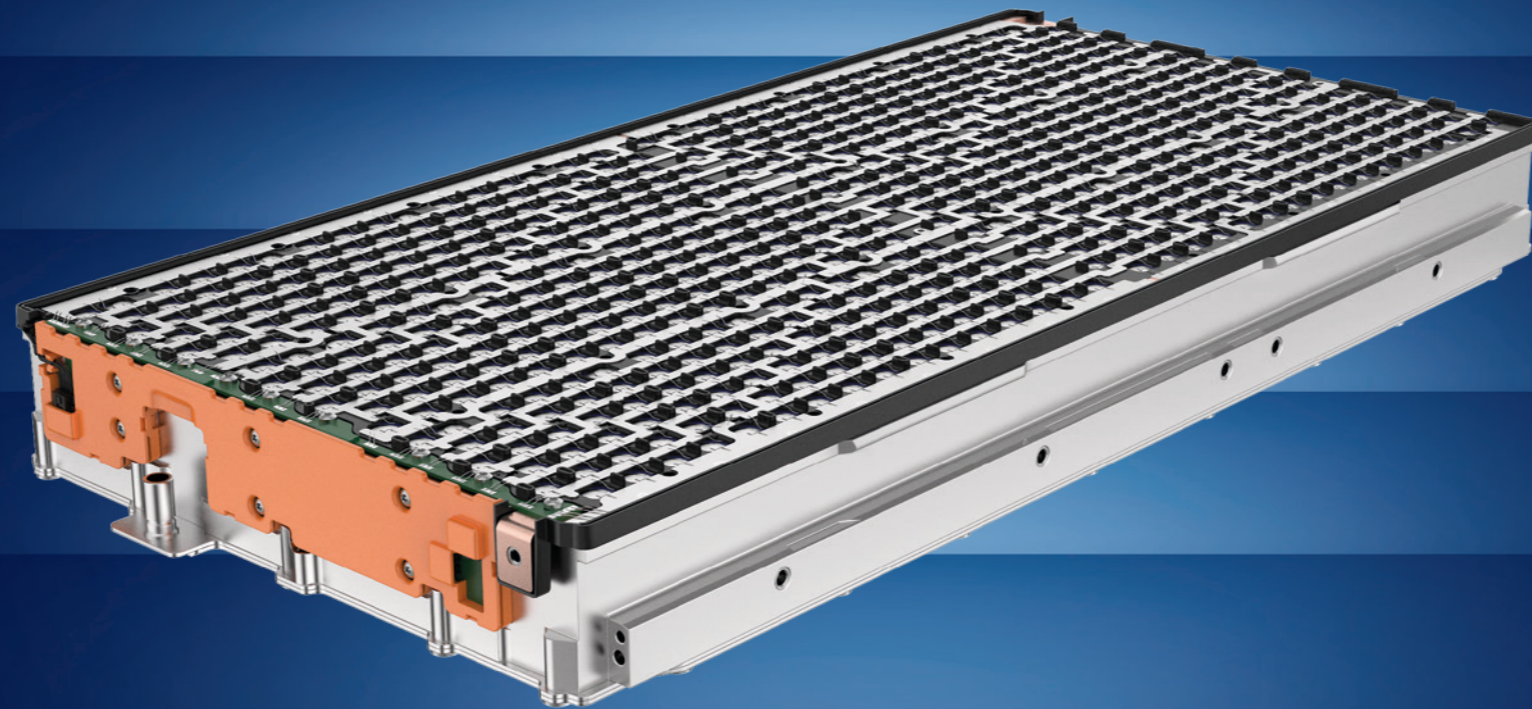
Pressure equalization elements from ElringKlinger with integrated safety function compensate for these pressure differences. The water vapor permeability also reduces condensate formation in the storage. An emergency degassing function integrated in the pressure equalizing unit opens up a large opening cross-section in the event of battery cell degassing, thus achieving a controlled pressure equalization in the storage housing that takes place as quickly as possible.

Pressure equalization elements  
in various designs



“With our modular battery modules and components we are in a position to offer series-ready, economical solutions even for smaller batch sizes or niche products.”

Gunnar Deichmann  
Vice President Battery Technology & E-Mobility



**OUR PORTFOLIO.  
FOR YOUR SUCCESS:**

- + Battery technology
- + Fuel cell technology
- + Electric drive units
- + E-mobility components
- + Lightweight and elastomer technology
- + Sealing systems
- + Shielding systems
- + Components from high-performance plastics
- + Dynamic precision parts
- + Tooling technology
- + Engine development services
- + Aftermarket



**ElringKlinger AG**

Max-Eyth-Straße 2  
72581 Dettingen/Erms  
Germany  
Phone +49 7123 724-0  
E-mail [info@elringklinger.com](mailto:info@elringklinger.com)

[www.elringklinger.com](http://www.elringklinger.com)

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