HIGHLY EFFICIENT, ENVIRONMENTALLY COMPATIBLE, FUTURE PROOF.







"Fuel cells offer a high power density, large range and short refueling times compared to e-vehicles using battery storage systems. This technology will play an important part in our automotive future."

Armin Diez, Vice President New Business Areas

### PARTNER. PIONEER. INNOVATION DRIVER.

## Shaping the future. With ElringKlinger.

More than a supplier: highly skilled partner, acknowledged mobility specialist, innovative visionary for all types of drive system.

# >10,000 EMPLOYEES AS PARTNERS.

We are a powerful and reliable development partner and series supplier to our customers. At the same time, we are pioneers and trusted companions – from the initial idea through to the finished product. More than 10,000 employees at 44 sites around the globe are committed to developing and producing high-tech solutions that are truly compelling.

## >140 YEARS AT THE LEADING EDGE.

Nothing beats experience blended with inventive spirit. ElringKlinger excels in both areas. In 1879, Paul Lechler established a trading company for technical products, thus laying the foundations for what was later to become ElringKlinger AG. Now operating as a global player, we provide future-proof solutions in a wide range of product categories and for all types of drive system. We are also demonstrating our exceptional abilities in other areas of industry. Among our key strengths are maintaining a close dialogue with customers, pursuing truly groundbreaking ideas, and tackling any challenges that may stand in the way of progress. And it has been this way for 140 years.

## >12 KEY FIELDS OF EXPERTISE.

ElringKlinger as an innovation driver. Emissions reduction, alternative drive technologies, lightweight engineering concepts, optimization of combustion engines: the automobile industry is undergoing transformation. The agenda for the future has been clearly defined. In this context, our abilities to turn vision into reality is by no means limited to our development center for e-mobility. We are able to answer together the questions of tomorrow today, going far beyond the field of fuel cell technology, and provide you with the key components for success.



# The E in ElringKlinger stands for electromobility.

The automotive industry is undergoing transformation. The focus is on sustainable mobility and alternative drive technologies. ElringKlinger has made the right decisions at an early stage, is influential in shaping these areas and will take you on a ride into the future.

## DEVELOPMENT AND TEST CENTER FOR THE MOBILITY OF THE FUTURE.

For some 20 years ElringKlinger has been researching alternative drive technologies. At our development center for e-mobility we combine research and development into battery modules and fuel cell stacks. And we work on further innovations for tomorrow's mobility. Even small batches of modules, stacks and systems are currently produced there. And these are thoroughly tested by methods including cell tests, module tests and component safety tests, all using the appropriate testing and safety systems.

We can therefore offer you optimal conditions for exploring new paths and achieving your objectives faster. Other automotive manufacturers and suppliers use ElringKlinger's extensive competence and implement their own developments and tests in cooperation with us. Reliably, economically and innovatively.



ElringKlinger operates a fuel cell research laboratory in China.

## ALWAYS ON THE GO: OUR INTERNATIONAL R&D TEAM.

ElringKlinger already manufactures innovative components for tomorrow's mobility, such as lithium-ion batteries in highly economical series production or cell contact systems and module connectors. In addition to this we develop and produce complete battery systems. In fuel cell technology ElringKlinger scores particularly for its own stacks, its patented designs for metal bipolar plates and its plastic media modules, which allow significant simplification of the fuel cell system.

Our aim: to drive innovation, set standards and help shape the technology transition with high-performance product solutions of the highest quality. For sustainable mobility. Worldwide.

## THE BEST CONDITIONS FOR FUEL CELLS.

Embossing, stamping and laser welding. Development and manufacture of plastic parts and seals. Integration of sensors and actuators: our established processes and experience in production technology from the production of conventional components have given us decisive advantages for series development and production in the field of fuel cells.

## TO THE LIMITS OF FORMING WITH OUR OWN TOOLMAKING.

Our in-house toolmaking facility enables us, for example, to go to the limits of forming when producing bipolar plates, thereby achieving the highest possible power density and service life in the stack. Development of new structures takes place on the basis of CFD simulation. Testing is done first on individual cells and short stacks, thereby ensuring that the results can be transferred. Our first series project involving e-mobility was launched back in 2008.

Armin Diez, Vice President New Business Areas

## GOOD TO KNOW:

The ElringKlinger product portfolio in the area of fuel cell technology includes:

- PEM fuel cell stack modules for integration into customer systems
- PEM fuel cell modules with periphery close to stack
- Stack components customized to customer specifications
- As well as standard solutions we can provide custom development for every level of integration

#### PEMFC STACK MODULES.

# Energy converters tailored to your needs.

Thanks in part to their robustness, our stack modules are suitable for use in both light commercial vehicles and passenger cars as well as in bus and truck applications. The use of the modules in ship and railway applications and in aviation is also conceivable. Thanks to the particular strength of fuel cell drive systems – their large range – fuel cells are also used as range extenders for battery-driven vehicles.



#### EXTENDED SYSTEM FUNCTIONALITIES AS STANDARD.

Usually, a fuel cell stack consists of a pile of cells consisting of bipolar plates, membrane electrode assemblies (MEAs), seals and end plates, plus the tensioning system. A stack module from ElringKlinger, however, also contains other system functionalities. These are integrated into a special media module made of plastic and typically contain sensors for pressure and temperature, valves, condensate separators for the anode circuit and optional customer-specific functionalities. These additional functionalities significantly simplify the integration of the stacks into customer systems and considerably reduce the potential for leakages in the system.

## HIGH PERFORMANCE THANKS TO INNOVATIVE, PATENTED DESIGN.

By using metal bipolar plates our stacks achieve a very high power density and thanks to their suitably designed end plates are even capable of starting in freezing conditions. Additionally, the interface for electrical connection to the system takes place via cable lugs. The contacts for single-cell voltage measurement are integrated directly into the stack. Thanks to the high quality of all the components used the voltage distribution across the cells is highly homogenous.

#### 07 // STACK MODULES

ElringKlinger currently offers three standard stack platforms. In addition, we offer customerspecific development so that we can offer stack solutions which are optimally matched for integration into the relevant system environment. And to offer you the decisive advantage in terms of capacity, functionality and robustness.

#### STACK PLATFORM NM5:

- Output range 6 to 70 kW
- Operating pressure up to 2.5 bar<sub>a</sub>
- Dimensions for 299-cell size/70 kW $_{\rm el}$ :
- W: 258, H: 180, D: 579 mm (incl. media module)
- Weight 27.7 kg
- Rated current 260A/390A (low-pressure/pressure mode)

#### STACK PLATFORM NM9:

- Output range 18 to 107 kW<sub>el</sub>
- Operating pressure up to 2.5 bar<sub>a</sub>
- Coolant up to 2 bar
- Dimensions for 399-cell size/107 kW<sub>el</sub>:
- W: 330, H: 150, D: 722 mm (excl. media module)
- Weight 35.3 kg
- Rated current 300A/450A (low-pressure/pressure mode)

### STACK PLATFORM NM12:

- Output range 33 to 150 kW
- Operating pressure 1.3 bar<sub>a</sub> to 2.5 bar<sub>a</sub>
- Coolant up to 2 bar<sub>a</sub>
- Dimensions for 449-cell size/150 kW<sub>el</sub>:
   W: 150, H: 594, D: 317 mm (excl. media module)
- Weight 38.2 kg
- Rated current 370A/570A (low-pressure/pressure mode)

## GOOD TO KNOW:

All the stack modules we offer are operated with hydrogen and air as the reaction media. For cooling, a commercially available glycol-based coolant for fuel cells is used.



PEM FUEL CELL MODULES.

## Would you like some more?

Not every manufacturer or supplier has the experience required to design and manufacture a PEM fuel cell system. To close this gap between the stack manufacturer and the OEM, ElringKlinger offers fuel cell modules in addition to pure stack modules.

#### ALL-INCLUSIVE PACKAGE INCLUDING PERIPHERY.

As well as stacks from the NM5 platform, an ElringKlinger fuel cell module includes the necessary periphery for integrating it into a complete system. This includes the control system, hydrogen pressure regulation, air filter, primary cooling circuit and the power electronics. Interfaces into the customer system are the supply and return air lines, the hydrogen supply at medium pressure and the removal of purge hydrogen and product water.

The hydrogen tank and secondary cooling circuit including chiller and the exhaust air system will vary with vehicle type and are therefore left to the customer. ElringKlinger offers support and comprehensive expertise for the integration of the module into the vehicle safety system, the electrical interfaces and the mechanical integration into the vehicle. A completely functional system will enable demonstration vehicles to be constructed quickly and also to be used in fleets in which a trusted system and safety concept is indispensable. As well as the standard systems offered, custom system development is also an attractive option, allowing the customer to profit from ElringKlinger's more than 20 years of experience in the field of fuel cell technology.

## APPLICATION AREAS OF ELRINGKLINGER PEM FUEL CELL MODULES INCLUDE:



Fuel cell modules are currently available in two performance classes, both of which contain two stack modules.

<b>FCM ТҮРЕ</b>	EK-FCM- NM5-LP-050	EK-FCM- NM5-HP-100
MODULE CONFIGURATION	NM5 dual stack Low pressure cathode	NM5 dual stack High pressure cathode
BOL OUTPUT [KW]	50	100
EOL OUTPUT [KW]	42	83
OUTPUT VOLTAGE [VDC] (HV DC/DC INTEGRATED)	500-750	
WEIGHT [KG]	< 200	< 250
DIMENSIONS / L X W X H [MM]	1000 x 700 x 320	1000 x 700 x 600
SERVICE LIFE [H]	> 12.000	
H <sub>2</sub> CONSUMPTION, NOM. [G/S]	1.0	1.8
H <sub>2</sub> QUALITY	ISO 14687-2, SAE J2719	
EFFICIENCY, MAX. [%]	56	58
AMBIENT TEMP. [°C]	-25 bis +40	
IP PROTECTION CLASS	54	
COOLING PROCESS (INLET) [°C]	≤ 60°C, 130 l/min Glysantin FC G 20-00/50	≤ 73°C, 240 l/min Glysantin FC G 20-00/50
COOLING ELECTRONICS (INLET) [°C]	_	≤ 60°C, > 25 l/min
LV SUPPLY [VDC]	24	
COMMUNICATION INTERFACE	CAN J1939	
NORMS AND STANDARDS	ECE-R 134, ECE-R 100, ECE-R 10	

## TECHNOLOGY IN DETAIL:

With fuel cell stacks the rated output per cell and thereby the current flowing to the cell surface are proportional. The stack output is obtained by multiplying the cell output by the number of cells in the stack, which can be varied according to requirements. Each format has a specific ratio of voltage to current, so that the optimal stack module can be designed for every application and system environment.

In addition to the fuel cell modules listed here, custom system developments or modifications are also available.



## INNOVATIVE FUEL CELL COMPONENTS.

## Good by experience.

We are experts in the development of manufacturing processes for large series and experienced with a large number of production methods and know-how in handling different materials. Decades of manufacturing 'classic' components help us to develop fuel cell components to a professional standard and manufacture them in series processes with exceptional quality, as well as adapt all components to the individual requirements of our customers.

**PEMFC METAL BIPOLAR PLATES** offer advantages in terms of cost efficiency, power density (of particular importance for mobile applications) and the cold starting ability of fuel cells. Using high-precision progressive tools capable of large series production we already produce metal bipolar plates in a fully automated and interlinked manufacturing process.

**ESSENTIAL INTERMEDIATE LAYER FOR PEM FUEL CELL STACKS.** Our PEMFC bipolar plates are used in PEM fuel cell stacks. These are piled up within the stacks alternating with membrane electrode assemblies (MEAs) – which are the actual active elements – and bipolar plates. Between them are porous elements which allow gas distribution and conduction of the electric current. The bipolar plate ensures separation of the media and its distribution through the stack, as well as uniform cooling of the stack and the conduction of current to the adjoining cells.

- + Made from high-alloyed stainless steel
- + Very low cycle time during embossing and joining
- + Various coating options available
- + ElringKlinger supports customers in developing a functional and manufacturable plate design
- + Our in-house tool development and toolmaking facility enables us to achieve a unique level of precision in the parts – the basic requirement for homogenous performance and long system life

SEALING SYSTEMS: As a specialist in sealing systems, and combining this with our knowledge of stack platform production, ElringKlinger can offer a range of sealing solutions.

TAILORED SOLUTIONS. Dependable and durable seals can be produced from our own materials or those specified by our customers, using injection molding, screen printing or other processes. These can then be fitted to the soft goods or also to the bipolar plates. We will work with you to develop an optimum solution that exactly matches your needs and requirements.







END AND MEDIA MODULES ensure a lasting, homogenous contact pressure for fuel cell stacks during tensioning across the entire cell area. The tensioning system thus consists of end modules and an optional media module.

**COMPLEXITY NOW IN SERIES PRODUCTION.** Series-compatible end modules for PEMFC stacks are hybrid assemblies of metal components and high-performance plastics which meet all requirements with excellent shape accuracy. They must – just as with media modules – be mechanically stable, chemically resistant and as weight reduced as possible. ElringKlinger develops highly complex end modules in injection molding, maintaining the smallest tolerances.

MEDIA MODULES WITH ADDED VALUE FROM A SINGLE SOURCE.

A particular feature of the modules we develop is the integration of system components directly into the stack in the form of a media module. This considerably simplifies the system. The media modules are also made and joined using injection-molded high-performance plastics in the series process.

Other system components produced in the injection-molded plastics process are also optionally available. These include, in particular, a hydrogen recirculation unit which is flange-mounted to the media module and ensures reliable circulation in the anode circuit by means of a nozzle. Further information and fact sheets about the individual products are available at www.elringklinger.com in the section entitled Products & Technologies.





The following system functionalities can be integrated into the media module, depending on requirements:

- + Sensors
- + Valves
- + Condensate separators
- + Media interfaces
- + Electrical interfaces
- + Bypass and cooling channels

As well as stack and fuel cell modules we offer a portfolio of stack and system components for fuel cell applications. Some of these have been supplied to OEMs and stack developers for years.

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