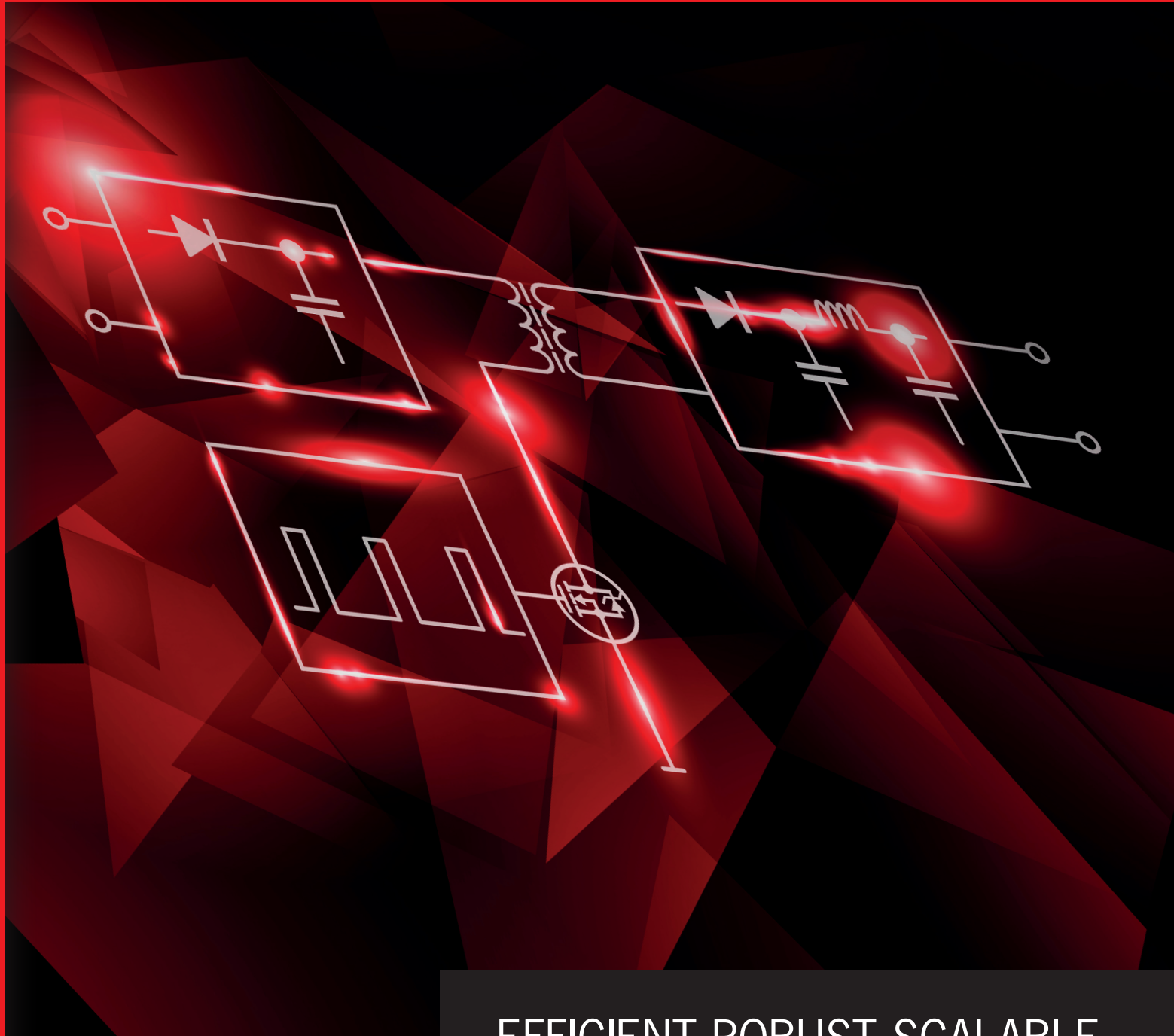


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ELECTRONICS WORLDWIDE



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## **RUTRONIK POWER**

### **The Markets are Changing**

Changing markets demand new solutions. Many markets are saturated, and products are being ever more replaceable and increasingly offering similar functionality thanks to growing standardization. Technological, regulatory and economic challenges along with growing functional complexity are a reality of numerous market segments, particularly for the industrial, automation, automotive and white goods (electronic household appliances for private and commercial use) segments.

### **Industrial**

Industrial applications place very high demands on technology and materials. Technology and materials must operate without fault and with high precision, especially when they are operating continuously and under extreme conditions. The failure of just one machine or application nearly always means production downtime and consequently the loss of profits. This can be avoided with the development of robust and reliable applications that satisfy a wide variety of requirements. Furthermore productivity and energy efficiency of industrial machinery and equipment have to keep increasing in the future. Ensuring the safety of the workforce operating these systems also has absolute priority.

Industry is presently on the threshold of the Fourth Industrial Revolution – “Industry 4.0”. At its core, this concerns the ever closer integration of the virtual world of information technology with the real world of production, driving products and the value chain even further into the digital realm. The global race to the next stage of industrial development has already long begun. Topics such as collaborative robots, smart products & services, networked production and logistics, innovative applications, and new forms of interaction have already long been a factor in industrial environments. But “Industry 4.0” will involve major changes not just at a technical level, but also in commerce and society. It requires cooperation between disciplines and between businesses, and acceptance of disruptive digital technologies and business models. But maybe the truly revolutionary thing about “Industry 4.0” is that it introduces a new type of industrial production that is not tied to specific segments or technologies.

## **Automation**

The automation industry is a reference in determining the pace of innovation, because in many cases automation is equivalent to increased productivity, reduced error rates and elevated efficiency. While automation technology may have originally been limited to the production of large series, the greater flexibility and standardization offered today increasingly enables the automation of small series production. This makes automation one of the most influential factors for the overall industry, because the most important innovations are expected in this field.

The suppliers of products, systems and solutions for the automation of factories, controlled processes and infrastructural networks, who have joined forces to form the Automation Division of the Central Association of the Electrical and Electronics Industry (ZVEI)<sup>1</sup>, anticipate growth of between four and five percent. This positive prediction is backed up by the strengths of the German automation industry in the field of industrial communication, in the development of smart components such as sensors, control systems and drive systems, and in the integration of such components into systems and complete solutions. The ongoing development of products and solutions in automation requires standardized and flexibly adaptable industrial services that are designed to encompass the entire lifecycle of an application.

Future system solutions will increasingly blur the boundaries between product and service. Function and service are dependent on one another in the application, and the service can even be part of the function. Examples include maintenance plans in machines and equipment based on condition monitoring and remote support solutions. These are required to ensure that operation can continue under optimized conditions. The integration of web-based communication in industrial applications is playing an increasingly important role in this context.

## **Automotive**

Car buyers are giving more and priority to new and more sophisticated consumer and safety solutions, and these require in-vehicle systems of ever increasing complexity and performance. Examples include radar and camera-based driving aid systems, as well as improved graphical output in infotainment, dashboards and heads-up displays. Some of these products are based on semiconductor and production technologies that cannot be made compatible with the needs of automotive engineering, which is why this discrepancy needs to be compensated for at application level. The technological miniaturization curve, which for decades provided an almost self-sustaining decline in costs, has reached a turning point at which successor products of similar technical complexity are often more expensive than their predecessor<sup>2</sup>.

Economic pressure and the desire for greater performance are driving the use of standard products in standard automotive applications. This means that many of the innovations demanded in vehicles are previously developed for larger market segments such as consumer goods to justify the necessary expenditure for research & development. Ultimately, products from various different markets are increasingly being installed in vehicles.

<sup>1</sup> <http://www.zvei.org/Verband/Fachverbaende/Automation/Seiten/default.aspx> (last updated: December 29, 2015)

<sup>2</sup> <http://www.zvei.org/Publikationen/Positionspapier-Consumer-Semi-Automotive.pdf> (last updated: December 29, 2015)

Automotive electronics were previously mainly developed under the top-down approach, in which the original equipment manufacturers (OEMs) would define their requirements and the partners in the value chain would develop new products & services to fulfill these requirements. This makes components specially developed for the sophisticated environmental conditions of the automotive industry different to those of similar applications for other markets. As a result, higher voltages, strong electronic discharges, higher temperatures, error correction and more stringent testing requirements have led to greater chip surface sizes. OEMs have already acknowledged that compromises are necessary to achieve the USPs and innovation in vehicles that the end consumer expects, but for all partners in the value chain, this means a fundamental change to the development process, moving away from the top-down approach and towards a flow of communication and cooperation between all parties within a closed circuit close connection.<sup>3</sup>

Accordingly, it will remain necessary in future to evolve processes in line with technological advancements for automotive applications and to adapt the requirements of quality, reliability, service life, safety and security accordingly. But at the same time, it will be necessary to make do with the current range of automotive components on-hand, ranging from consumer to “traditional”.

### **White Goods**

The future of smart home appliances lies in the smart grid, an intelligent electricity supply network. Additional improvements are becoming technically more advanced and therefore ever more expensive. Consumers will only reward this additional investment if the higher purchase price is balanced out by savings in energy costs and also if no compromises are made in other aspects such as convenience. Energy efficiency must therefore go hand in hand with greater operating convenience and useful functionality. Hence, the goal is to achieve both energy efficiency and quality, saving energy without cutting back on functionality.

The manufacturers have already reached this stage on a technical level, but there is still some work to be done before this can be applied universally. Not only do standards need to be developed to enable the system's components from different device manufacturers and energy providers to be able to communicate with one another, but it is also necessary to develop and expand the infrastructure, the smart grid. This includes the universal installation of smart electricity meters in households, because it remains the case here as well that the consumer will only invest in smart devices if they can derive a financial benefit from them. This is another reason why clearly differentiating between products and services will become increasingly difficult in future system solutions. Function and service are dependent on one another in the application, and the service can even be part of the function.<sup>4</sup>

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<sup>3</sup> <http://www.zvei.org/Publikationen/Positionspapier-Consumer-Semi-Automotive.pdf> (last updated: December 29, 2015)

<sup>4</sup> [http://www.zvei.org/Publikationen/ZVEI\\_LF\\_Industrie-Services\\_Download\\_01.04.15.pdf](http://www.zvei.org/Publikationen/ZVEI_LF_Industrie-Services_Download_01.04.15.pdf) (last updated: December 29, 2015)

## Trends in High-Performance Electronics

In addition to the trends in the market segments, there are also developments that are affecting the entire high-performance electronics sector. The most important of these developments are “digital power” also with the related topics of “functional safety” and “robustness”. These have direct effects on operating conditions, technology and manufacturing methods.

### Digital Power

One “power future trend” is that of “digital power”, also referred to as “intelligent digital power”. In electrical engineering, this buzzword refers to digitally controlled or monitored power supply units. In conventional switched-mode power supply units, an analog switch controls and monitors the output voltage. In digital power supply units, a microcontroller or DSP handles one or several of these functions. The control process is integrated into the controller at software level. One of the major advantages of digitally-controlled switched power supply units over analog solutions is the option of being able to intervene in the control process at any time and to adapt it to the current needs of the power supply. While this increases the level of effectiveness of the digital PSU compared to an analog variant, this does also increase the amount of technical development work required, which is reflected in the costs.

Digital technology aims to satisfy the needs of the now ever more complex power supply systems. In digital power supplies, we differentiate between “power control” and “power management”.

“Power control” refers to the control functions within a power supply unit itself, including the feedback loop and the internal functions. “Power control” must operate under strict real-time conditions, perfectly synchronized with the switching frequency of the power supply unit. This type of control can be implemented in both analog and digital circuits.

“Power management” on the other hand relates to the communication and/or control outside one or several power supply units. This includes functions such as configuration, control and monitoring of individual power supply circuits of a system, as well as fault detection communications. Power management functions do not need to run in real time, instead they work at much slower intervals than the switching frequency. These functions combine analog and digital technologies e.g. by using resistors to adjust the output voltage while the power sequencing requires control connections to each power supply.

### Functional Safety and Robustness

Innovations that do not take safety into account cannot endure, which is why high functional safety and robustness are essential. In a robustness validation, for example, the reliability of electronic components is assessed by comparing the specific product requirements against the actual service life, taking into account the increase in efficiency. The fundamental concept behind functional safety is the strategy for reducing actual risks. The goal is to create a safe system in that every reasonable measure has been taken to avoid damage to property and danger to people, ensuring traditional safety measures. In automotive engineering, functional safety is a relatively recently new topic. Its origins lie in other industries such as plant engineering, aviation and the rail industry.

## Effects

These trends cover many industries and are directly related to operating conditions, technologies and manufacturing processes. In other words, changes to operating conditions or other techniques or manufacturing processes will also mean the involvement of different requirements imposed upon the installed components. This can be more clearly illustrated in the example of energy storage. If the conditions in which a battery is operated or if new technologies or manufacturing processes are implemented, this gives rise to new requirements imposed upon the charging strategy or the battery management system.

The operating parameters are of critical importance to the service life of an energy storage facility within an application. While developers often have no influence on the operating conditions, there is scope for optimization in the battery management system, although this scope is often used inadequately. As a result, operating conditions are changed without implementing the battery management system accordingly. In this connection, the most frequent recorded electrical failures are due to defective or discharged starter batteries.

Specifically in the automotive industry, such battery failures were mainly found in luxury vehicles until the year 2000. The main cause was the growth in electronic component use and other electricity consumers in the vehicles, because even in a parked vehicle, the starter battery is constantly being discharged by the monitoring and control electronics. While the currents involved here – referred to as “standby currents” – are low, the battery can suffer from deep discharge if left dormant for long periods of time.

## Applications are Complex

The example of a frequency converter helps to illustrate the complexity of an application.

In a modern frequency converter, a large number of components not only from the passive segment but also the active and electromechanical segments are required.

- Numerous connections and connector systems for a variety of applications such as signal/data transmission are required. The transmission of different voltages and currents, i.e. different power classes, is becoming ever more important.
- The temperature resistance of the contact surfaces and the low contact resistance of each connector must be taken into account.
- The efficiency of a frequency converter is dependent on the selection of the semiconductor modules. This makes it very important for modules to be used in the voltage converter range – the range in which voltages are to be converted, for example to supply the controller unit – that have a high efficiency as per  $P_{out}/P_{in}$ . This can be achieved either by discrete means or using modules with “high efficiency” properties.
- The product must be protected against grid volatility and/or voltage spikes, which can be achieved using protection circuits such as ESD diodes.

- The controller unit, the “core” of the product, today handles the entire management, for which different internal or external communication systems such as CAN or LIN can be used. This is also where analyses are performed using data processing cycles on the  $\mu\text{C}$ .
- Measurements supplied from various sensors, transformers, etc. as analog signals must be converted into binary code in the controller. This conversion is used not only as feedback for the user but also for other data processing or control cycles.
- The power amplifier is a widely varying collection of components that plays a key role in the overall concept. The power amplifier is a complex unit that consists of various components such as shunt resistors, MOSFETs and even IGBT modules, diodes and other power modules. Parameter optimization is very important here, for example in relation to the PCB design with regards to currents, and also to EMC or heat management.
- Passive cooling is always preferable. If this cannot be achieved, the use of fans becomes necessary. The type of cooling here in turn plays a very great role – an optimized cooling concept needs to be developed.
- Based on the cooling concept and the dimensions of the application, it is determined whether the cooling needs to be achieved using axial, tangential or oblique fans.
- Much like efficiency, the operation of the frequency converter is a very important aspect. The operation of electrical devices is increasingly moving towards visual displays or “touch” displays. There are important criteria to be taken into account here, among them dust and spray protection and display readability.

While this list does not claim to be exhaustive, it does demonstrate the relentless pace at which the complexity of applications is growing, in particular in relation to the interdependency of individual components and of environmental parameters. For manufacturers, this raises the question of whether this know-how needs to be developed internally or whether the market might offer a suitable solution.

## **The Answer – RUTRONIK POWER**

RUTRONIK POWER is much more than a complete portfolio of power components for various voltage classes and different applications. RUTRONIK POWER also offers a selection of components for a variety of applications suitable for the respective circuit.

This means that under every position in the block diagram, there are products from multiple selected suppliers in the respective product segments. RUTRONIK accommodates as broad a range of requirements as possible here – whether low-cost or high-performance. For example, for a motor control circuit in the power range of 2KW, RUTRONIK offers appropriately designed IGBT modules, gate drivers as well as microcontrollers, driver modules, heatsinks and plug connectors.

For power semiconductors, RUTRONIK caters for everything today, from discrete to high-integration components, power ICs and power modules. As a broadline distributor, RUTRONIK offers all other components in addition to its power semiconductors, not only active but also electromechanical and passive components. The spectrum ranges from simple plug connectors to supercaps. This covers around 98% of the PCB. This also applies to other product segments such as high-current connectors supporting up to 1,000A and supercaps supporting up to 3,400 farad/cell.

But RUTRONIK POWER is much more than a broad selection of components. The decisive difference lies in RUTRONIK compiling relevant expertise, not only for individual products and technologies, but also on their compatibility with one another. This helps to guarantee extensive support – with development at application level by professionally qualified Field Application Engineers (FAEs), Product Managers at component level and supply at the end of a product lifecycle lasting several years. FAEs are particularly important for technical customer support. RUTRONIK's experts advise and support activities ranging from the design-in process, the product evaluation and application development, the strategic marketing of product groups for which theoretical assistance is necessary, down to the development of logistics solutions with comprehensive system solutions that are optimized to the customer's needs. RUTRONIK POWER focuses less on individual components and more on the overall solution.

RUTRONIK gives absolute priority not only to reducing the prevailing complexity of the offer-range but also to providing support at the product development stage at application level with relevant technical expertise and vertical system solutions based on suitable components.

## **The Advantages**

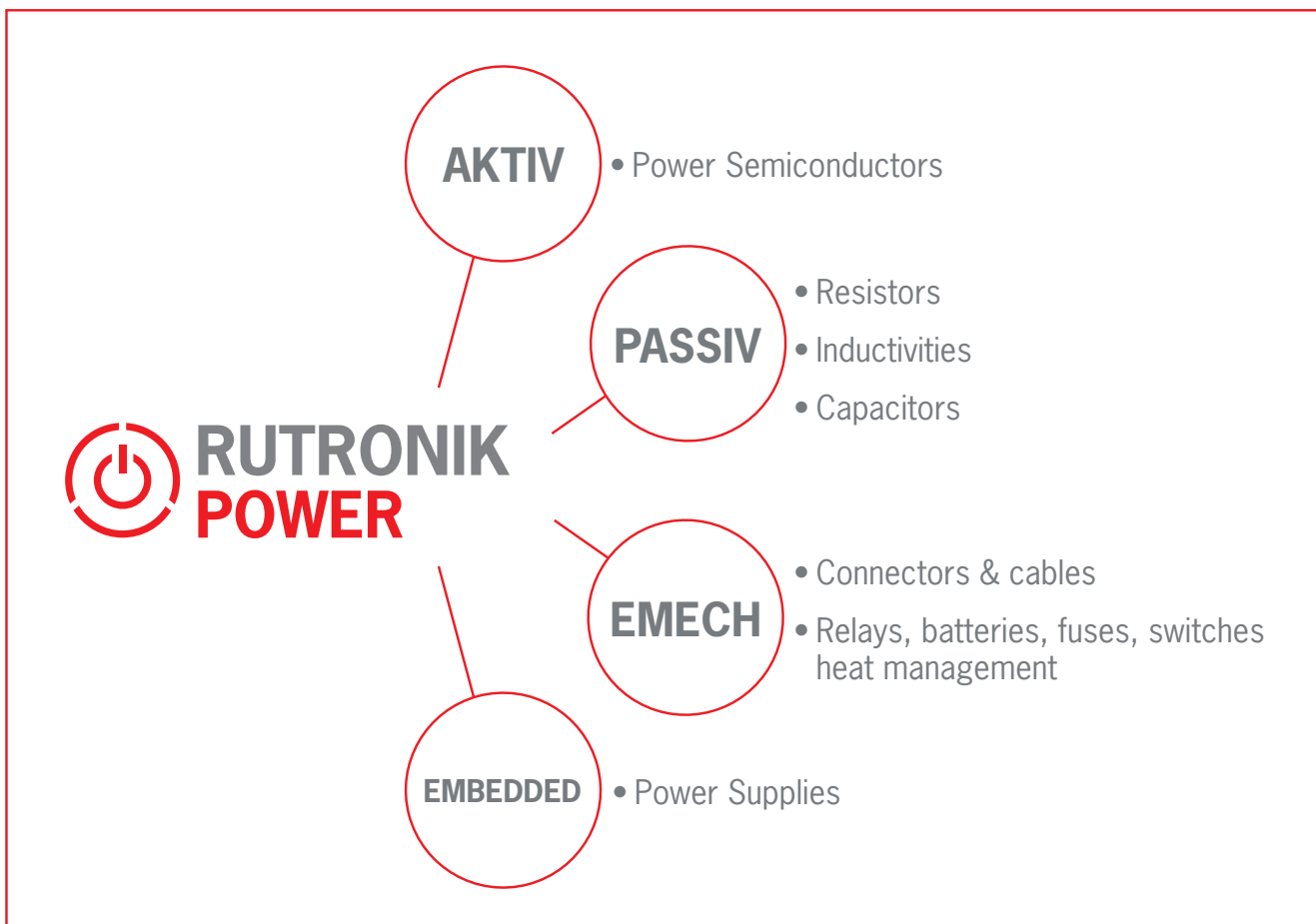
RUTRONIK POWER serves as a single source for all components, from individual components to a basis for operational applications. But RUTRONIK POWER does not compete with its customers with its own components and applications, because the extensive range is combined into complete, vertically integrated system solutions. The product portfolio consists of decided manufacturers who are leaders in their respective fields and with some of whom the company has worked for decades. This ensures an extensive and consistent transfer of knowledge from the very start, both between the supplier and RUTRONIK as well as a collective exchange of expertise with the customer, for example concerning seminars, webinars and professional conferences.

The bundling of expertise and experience in the RUTRONIK POWER team guarantees that the customer receives extensive advice in respect of the overall application, the market and its requirements. RUTRONIK's experts have a profound understanding of all relevant factors, with specialists from a variety of fields supporting each other (see Figure 1), enabling the benefit of synergies across teams to be utilized more effectively, because market segments overlap in numerous aspects – and customers benefit from such coordinated consulting. This understanding of not only the customer's requirements but also the technical options and the market conditions enables a precisely tailored solution to be developed – not off the shelf, but customized specifically to the customer's needs.



Working with the customer and with its suppliers, RUTRONIK develops forward-looking approaches, thereby contributing to research and development at application level. This is why RUTRONIK provides tools for certified applications that stand out not only with their extraordinary functionality, quality and robustness but also with their energy efficiency. And this is exactly what RUTRONIK POWER is there for.

The RUTRONIK POWER team consists of specialists from the active power semiconductors, passive, electro-mechanical and embedded segments, utilizing the company's extensive product portfolio.



**Figure 1: The "RUTRONIK POWER" team of specialists**



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