MicroSys
Creating Embedded Systems

Whitepaper

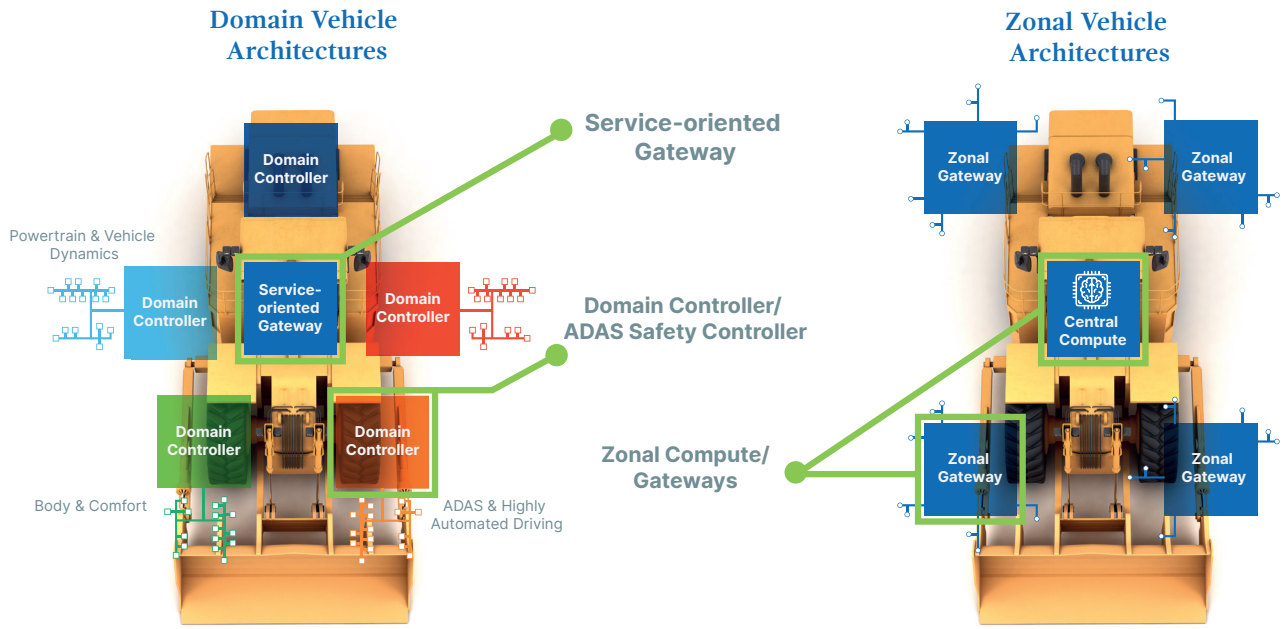
Application-ready vehicle network processing platform

System-on-Modules with NXP S32G2 processor
for functional safety applications

NXP GOLD PARTNER

Introduction

The NXP S32G274A is an automotive- and industrial-grade vehicle network processor that integrates applications processing, real-time processing, heterogeneous network interfaces and acceleration, hardware security and ISO 26262 ASIL D functional safety support. As the world's first System-on-Modules manufacturer, MicroSys has qualified it for use in industrial applications and integrated it in an application-ready System-on-Module (SoM). Typical application areas for this processor module include real-time connected vehicles, mobile and stationary machines, as well as automotive test equipment.



→ NXP S32G2 automotive processors power service-oriented gateways, domain controllers and ADAS safety controllers, or serve as zonal computers/gateways.

In today's age of digitalization, Industry 4.0 and the Internet of Things, high-throughput connectivity is one of the most critical functions for devices of all kinds. This applies also and particularly to the smart mobility sector, where the number of vehicles that is connected 24/7 via 5G to service-oriented gateways is growing. This constant connectivity makes it possible to exploit the full potential of the vehicle data and to deploy new services and functional enhancements quickly and efficiently. Other domain controllers support functions such as infotainment and in-vehicle experience, body and comfort, powertrain and vehicle dynamics, as well as safety and security for ADAS/driver assistance systems. Increasingly, autonomous driving functions are also required. The data transfer between the individual domain controllers or zonal computers/gateways and the local sensors and actuators must be processed and orchestrated with as little latency as possible.

Need for high data throughput

Such gateways are expected to deliver ever more processing performance and data throughput to satisfy new requirements such as cloud connectivity for fleet management or vehicle subscriptions, V2X communication, new ADAS functions and autonomous driving, as well as zero downtime OTA capability. In addition, they must be real-time capable and ultra-secure – both in terms of ASIL D safety and hardware security. This applies not only to major vehicle and mobility brands, but also to any new commercial, construction or agricultural vehicle, overland and subway trains, and all other types of mobile vehicles such as autonomous warehouse robots and drones.

The NXP S32G2 processor sets a new benchmark in this area: Compared to NXP's previous automotive gateway platforms, the S32G274A delivers 15,900 D-MIPS (Dhrystone MIPS), which translates into more than ten times faster real-time and network performance.

To achieve this performance leap, the new S32G2 processors integrate microcontrollers, application processors, network accelerators and a dedicated Hardware Security Engine (HSE) on a single chip. For the very first time, this gives developers access to enough high-bandwidth processing power and high-performance connectivity to run tactile Internet applications with real-time 5G communication. The gigantic performance boost is primarily made possible by the integration of several previously separate functions in a single-chip design, thereby combining more overall performance on one die. This higher level of integration also has another advantage of allowing direct communication via the integrated safe fabric offers lower latencies than when external components are involved. The integrated lockstep functionality for detecting errors during execution and data transmission, along with monitoring of other hardware-related faults, is yet another attractive feature for safety applications.

Native interfaces free up CPU capacity

Besides high-performance, connected vehicles and mobile machines also need native support of all relevant peripheral interfaces, such as CAN, FlexRay and LIN. Alternative connected vehicle designs using generic extension buses to connect CAN controllers generate high interrupt loads that slow the main processor down unnecessarily. FPGAs are not a cost-effective alternative either and require additional development resources for FPGA programming. Having automotive fieldbuses (20x CAN FD bus, 2x FlexRay and 7x LIN) natively integrated on the chip is therefore a highly attractive option to ensure that even the most complex subsystems are addressed without the latencies caused by the otherwise required USB-to-fieldbus components. This also avoids the need for expensive FPGA designs. The Low Latency Communication Engine (LLCE) for CAN, FlexRay and LIN, which is optimized for data transfer, and the Packet Forwarding Engine (PFE) for processing IP packets from Ethernet networks greatly reduce the CPU workload. A firewalled Hardware Security Engine (HSE) for secure boot, security services, key management and encrypted data transfer provides a solid root of trust, which is essential for secure IoT edge systems.

High-performance Arm cores

The NXP S32G2 processor orchestrates four 1 GHz Arm® Cortex®-A53 cores with Arm Neon™ SIMD technology, organized in two clusters for applications and services. They provide up to 2.3 DMIPS per core for multipurpose applications and are clocked at 1 GHz. In addition, there are also three integrated Arm Cortex-M7 dual-core lockstep processors. Applications requiring dedicated co-processors, for example to machine motion control applications, can take perfect advantage of the three Arm Cortex-M7 dual cores. They support real-time operating systems such as AUTOSAR or FreeRTOS.

Integrated functional safety

For safety-critical applications, both the Arm Cortex-M7 and A53 cores can be operated in lockstep mode. Where required, the M7 cores can work in 2oo3 voting mode to ensure that when core pairs provide different results, the result provided by two pairs is valid. This way, the heterogeneous computing cores can support ASIL D applications as well as any other functional safety standard analog to IEC 61508.

Safe communication

The integrated HSE provides comprehensive security functions for high data and application security. These include cryptography functions for data encryption and decryption as well as the generation and verification of MACs and signatures. Secure boot provides a memory check at system startup. In addition, HSE provides real-time hardware-accelerated SSL/TSL network communication and supports IPsec. The HSE also provides random number generation capabilities and secure key management capabilities, along with resistance against side-channel attacks.

Fast communication

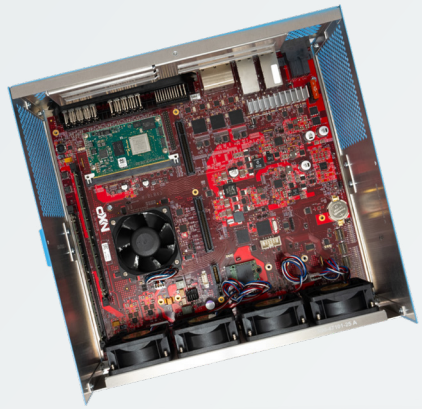
The Low Latency Communication Engine (LLCE) is responsible for handling the entire data flow for the classic automotive buses such as CAN, LIN and FlexRay. It frees the host CPU from all I/O tasks and from handling 100's of thousands of interrupt requests to process the data. The Packet Forwarding Engine (PFE) is responsible for Ethernet IP packet processing, such as handling checksum calculation and conversion as well as header verification and manipulation, supporting virtual LANs and performing packet routing. It also integrates a stateful inspection firewall to provide protection against malicious external attacks, with the ability to be used for intrusion detection capabilities.

System-on-Modules

Developers of applications for commercial vehicles, mobile machines and new e mobility solutions that are only manufactured in industrial batch sizes, however, cannot afford to develop and integrate such complex gateway processor technology, along with all the required additional components and complex BSP, into their systems from scratch. Instead, they must concentrate on their core competencies, which are primarily in application development and ultimately differentiate them from the competition. This is where application-ready COTS platforms help as they enable the development of customized solutions without the need to spend a lot of time on the design of the central computing core. System-on-Modules, which are delivered as COTS components with everything needed for application development and certification, are increasingly popular for this purpose. They already integrate function-validated drivers for all supported interfaces and provide ready-to-use OS images from boot up to login. This saves time and increases design security, especially since the modules are not just used for one but different designs and therefore come with a comprehensive set of pre-validated functions. As a result, they provide an extremely solid basis for the efficient design and implementation of customized control and gateway solutions for vehicles as well as mobile and stationary machines of all kinds.

NXP Gold Partner MicroSys Electronics has integrated the S32G2 on the miriac® MPX-S32G274A System-on-Module (SoM) with a guaranteed availability of at least 15 years. This is a sufficient length of time to allow for the average 2-3 year integration and acceptance of such solutions, while also ensuring a long product life and sustainable spare part procurement. All components on the module are specified for the temperature range of -40 °C to +85 °C. The processor is even designed for the AEC-Q100 Class 2 temperature range (at least -40 °C to 115 °C). A low TDP (Thermal Design Power) also makes passive cooling an option. The system platform is therefore optimized by design for the challenging operating conditions in mobile vehicles.

Meeting the technical requirements for use in all types of vehicles is not the only crucial benefit of the new modules. Even more importantly, they come with all necessary documentation to simplify reuse in customers' own certifications and documentation. This reduces the complexity of the approval process significantly for customers. Another benefit is that OEMs have access to competent experts to help them with any questions, for instance regarding safety-relevant software implementation, which is crucial for developers of IEC 62443 compliant industrial cyber security as well as ISO 26262 compliant functional safety solutions. These fundamentals can then be ported to all other industries with functional safety requirements, for example to meet standards analog to IEC 61508 – including railway technology (EN 50155), stationary and mobile machinery (ISO 13849), industrial robots (ISO 10218), control systems (IEC 62061) and drive systems (IEC 61800-5-2). Approvals in the aviation context (DO-254/DO-160) are also greatly simplified by the existing manufacturer documentation.



NXP has chosen a MicroSys SoM

NXP's BlueBox 3.0 is an example that illustrates the efficiency of SoM-based designs. Processor manufacturer NXP has chosen this approach and integrated the miriac® MPX-S32G274 SoM, which is based on the NXP S32G274 processor, in their scalable development platform for safe automotive high-performance computing. The reason: It is much easier and more efficient to design-in an application-ready super component that already integrates the processor, RAM and flash than to start a full custom design from scratch. Developers are therefore well advised to use SoMs when designing their own board. One major challenge, for example, is ensuring signal integrity and quality. At very high frequencies, length matching, line impedance and impedance jumps are particularly taxing. Therefore, it is for instance necessary to use a special PCB material. And because the BGAs are packed extremely densely, the PCBs need to have more layers. With SoMs, customers get a less complex PCB for the custom carrier board. The result: a simpler layout, lower PCB costs and high signal integrity.

The feature set of the SoM in detail

The new miriac® MPX-S32G274A SoM from MicroSys Electronics is available as an application-ready off-the-shelf component or as a development kit with carrier board, cable set and cooling solution. In terms of memory, the new SoM integrates 4 GB of soldered LPDDR4 RAM at 3200 MT/s, 32 GB eMMC non-volatile memory and 64 MB QuadSPI flash. External SD card storage can be multiplexed with the onboard eMMC.

For connectivity, the new SoM offers an extensive set of interfaces, including 4x SerDes interfaces, configurable as PCIe Gen3 2×1 or 2×2, 4x Gigabit Ethernet, 18x CAN FD Bus, 2x FlexRay and 4x LIN. 14x GPIOs, 12x analog inputs (ADC), 3x SPI, 2x UART, 1x USB and 3x I2C complete the interface range. For trace and debug tasks, the SoM supports Aurora and JTAG interfaces.

A comprehensive board support package for Linux, including bootloader configuration and all required drivers, rounds off the feature set. Besides standard automotive support from NXP, MicroSys also offers optional support for dedicated FreeRTOS implementations for the Arm Cortex- M7 dual-core lockstep processors. For more information, visit:

miriac® MPX-S32G274A

A perfect solution for stationary outdoor equipment

The S32G processor is also a good fit for industrial applications at a fixed outdoor location. From e mobility charging stations to critical infrastructures (KRITIS) for trains, electricity, oil and gas pipelines or public safety systems: Next to fast connectivity and high data throughput, they all need extended temperature support, a requirement the new miriac® MPX-S32G274A SoMs from MicroSys Electronics fulfill by design.

Ideal for test equipment in automotive development

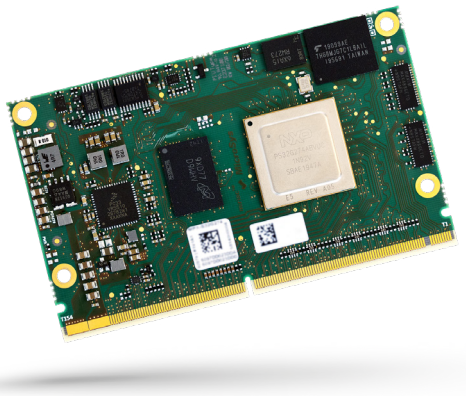
Anything that is deployed in vehicles must be extensively tested and logged in the prototype phase to track down errors and optimize the entire vehicle electronics. MicroSys develops individually customized carrier boards and system designs for automotive test equipment and service providers. Since such platforms do not require complex certifications due to their intended use, the MicroSys development teams can quickly deliver them in small to large quantities, not least thanks to close collaboration with local component manufacturers.

Mobile test and measurement equipment for automotive workshops

The stationary and cart-mounted test and measurement equipment used in automotive workshops must keep up with the rising performance of the chips installed in vehicles and be able to take more and more measurements at ever higher data rates and data depths. Test systems built on the same platforms as those used in the vehicles can keep up by default and natively support the given vehicle interfaces. MicroSys SoMs and carrier boards usually offer the entire functionality off-the-shelf. If test and measurement systems are already developed for the prototype phase, the path to certified series production is not long.

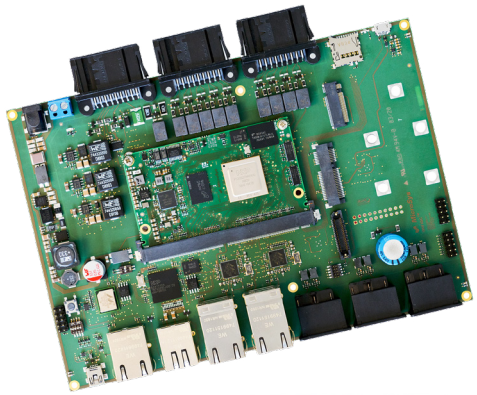
SIL certifications for all industries

In addition to application-ready hardware and function-validated hardware-related software, MicroSys Electronics also offers customer-specific design services at carrier board and system level. These extend to SIL certification for all sectors in which functional safety standards analog to IEC 61508 are required. This includes railway technology (EN 50155), stationary and mobile machinery (ISO 13849), industrial robots (ISO 10218), control systems (IEC 62061) and drive systems (IEC 61800-5-2). Approvals in the aviation context (DO-254/DO-160) are also greatly simplified by the existing manufacturer documentation.



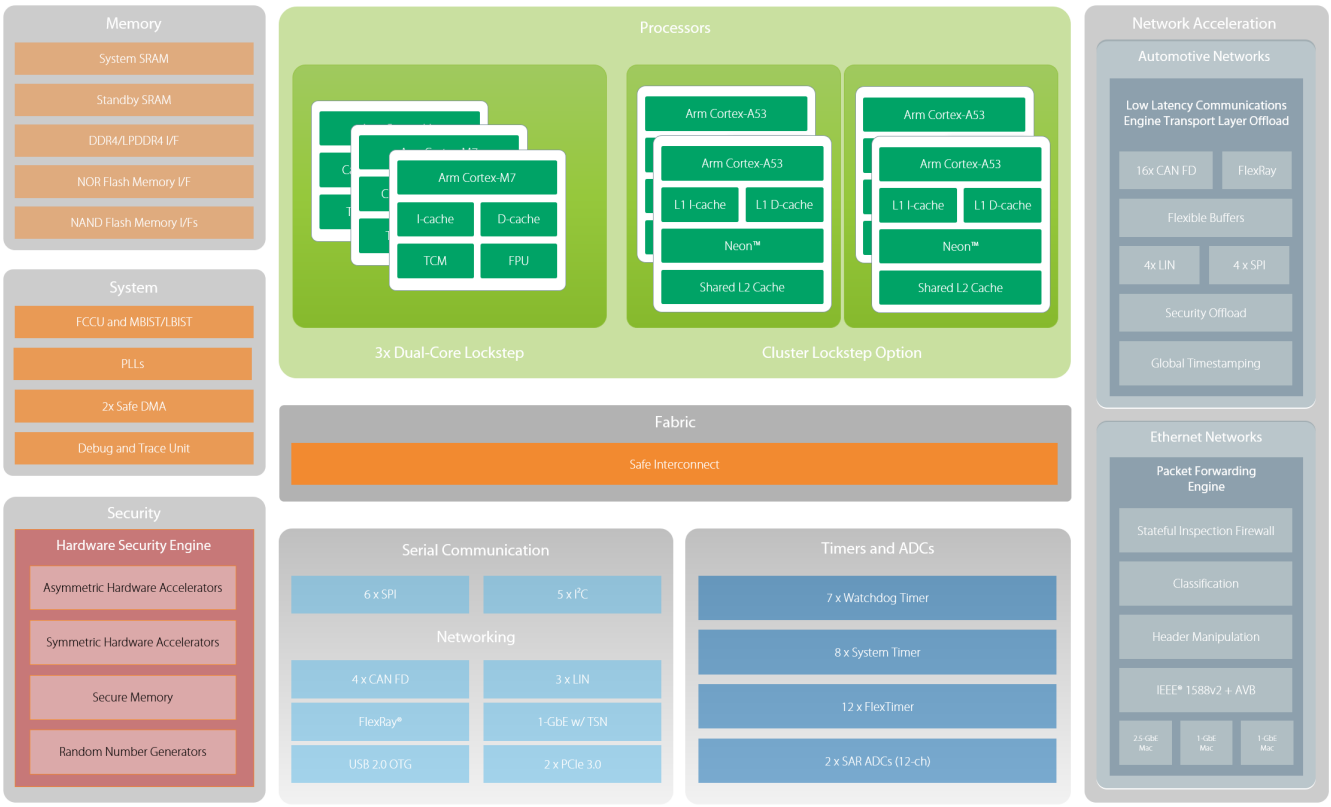
→ The MicroSys miriac® MPX-S32G274A is the world's first System-on-Module to integrate the new NXP S32G2 processor, which is specifically designed for automotive networks.

miriac® MPX-S32G274A

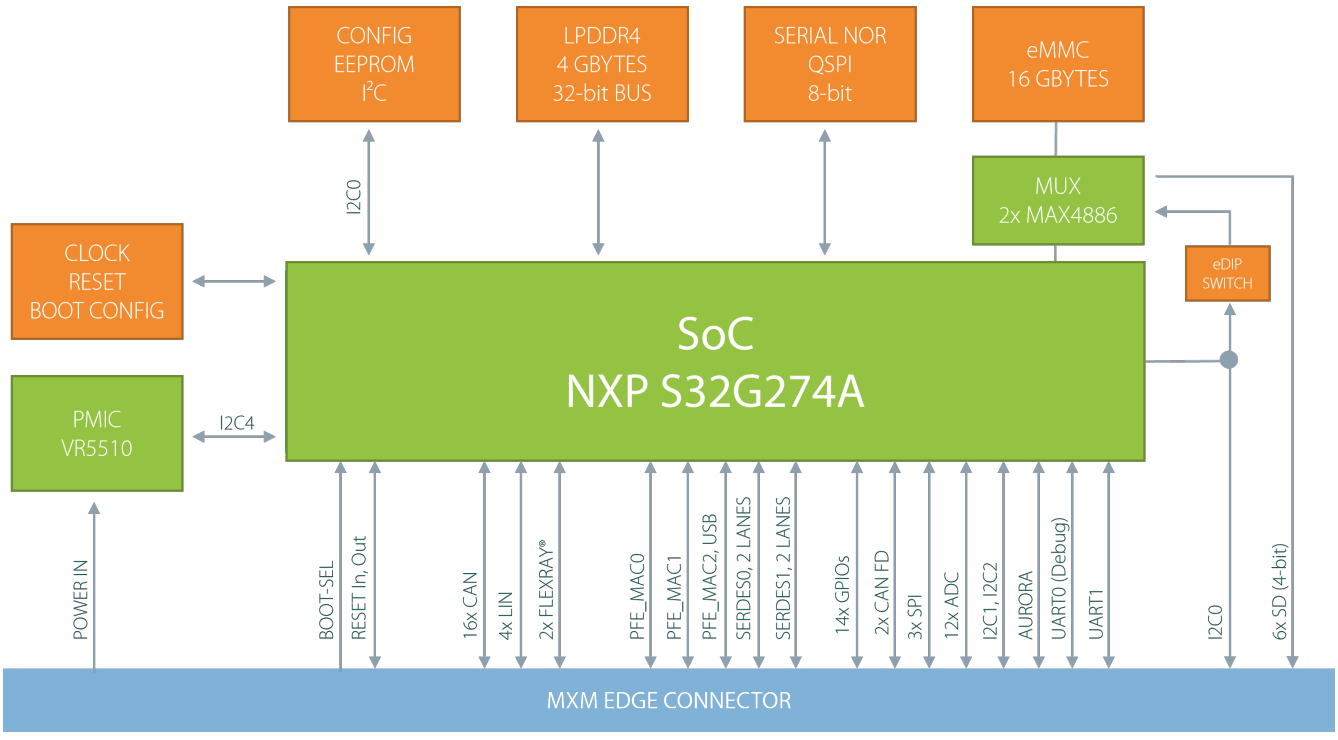


→ The application-ready miriac® SBC-S32G274A single board computer is also available as a starter kit, serving as an evaluation and target system for development. Based on the NXP S32G274A vehicle network processor, it integrates a miriac® MPX-S32G274 System-on-Module from MicroSys. The system combines multiple high-speed Ethernet interfaces for vehicle networking – provided by the SJA1110 automotive switch – with standard automotive buses such as FlexRay (2x), LIN (4x) or CAN (16x plus 2x CAN FD). It is the perfect communication and computing solution for innovative automotive and industrial sensor fusion applications.

miriac® SBC-S32G274A



→ The NXP S32G2 processor offers a wide selection of native interfaces, which reduces latencies.



→ The MicroSys miriac® MPX-S32G274A System-on-Module provides developers with an easy-to-integrate platform that includes all I/Os of the NXP S32G274A processor, all required core components such as RAM and eMMC data storage, as well as additional interfaces.

MicroSys
Creating Embedded Systems

Author: Christian Bauer, Key Account- & Product Manager

About MicroSys Electronics

MicroSys Electronics has been designing and developing embedded system solutions since 1975, is an NXP® Gold Partner and widely integrates NXP®'s S32 Automotive, Layerscape® and QorIQ® processor technology. Designs based on System-on-Modules (SoMs) are the strengths of this German company, with the portfolio ranging from application-ready SoMs and customer-specific carrier board designs to fully integrated systems. Application areas for these extremely rugged designs with long-term availability are primarily found in markets where safety standards analog to IEC 61508 are required, such as railway technology (EN 50155), aviation (DO-160), and mobile machinery (ISO 13849), as well as manufacturing robots (ISO 10218), control systems (IEC 62061), and drive systems (IEC 61800-5-2). Further application areas can be found in medical technology (60601), and in critical infrastructures, like the nuclear sector (IEC 61513) or the process industry (IEC 61511). MicroSys works closely with its customers in all these industries to ensure that the specific applicable standards are fully met.

For more information, visit www.microsys.de

NXP GOLD PARTNER

MicroSys Electronics GmbH

Mühlweg 1
82054 Sauerlach, Germany
Tel: +49 (8104) 801-0
Fax: +49 (8104) 801-110
Web: www.microsys.de
Email: info@microsys.de