Automotive safety: Having the right product portfolio in place

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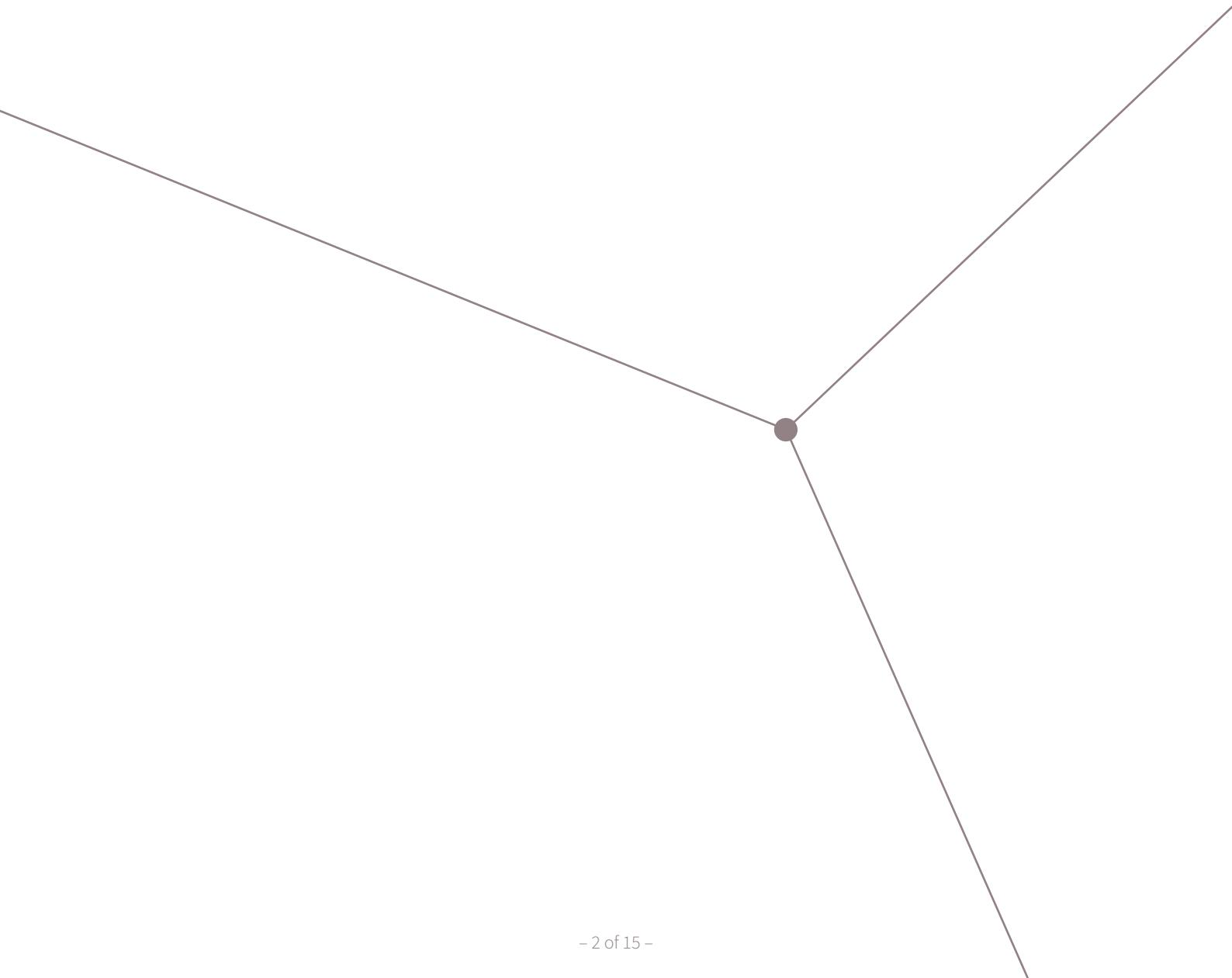
Abstract

Changes are happening in almost every aspect of automotive technology, although the main thrust can be encompassed in three megatrends. In the future, vehicles will be increasingly connected, and therefore cybersecurity protection is becoming more and more important. e-Mobility will be a major contributor to CO_2 reduction, resulting in a need for high-power semiconductors. And automated driving will require more complex components to support safety-related applications.

Safety is a prime consideration in all vehicles, and a primary driver for greater automation, thereby removing reliance on the leading cause of accidents – the driver. For many years now, ISO 26262 has been the leading standard setting out requirements and guidance on what a product has to achieve in order to be used in an automotive safety application.



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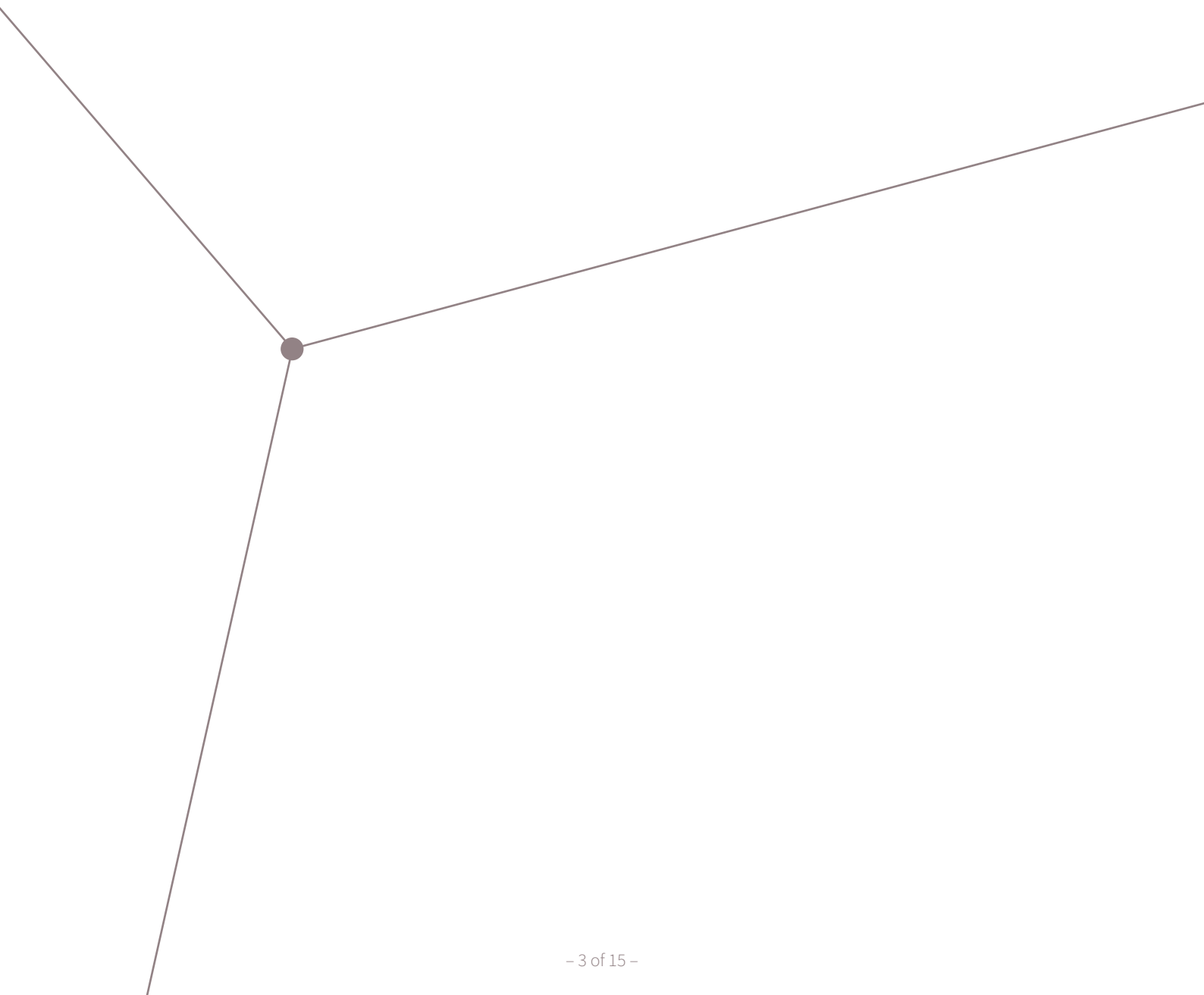


1. Achieve system dependability with Infineon PRO-SIL™ components

Depending on the required Automotive Safety Integrity Level (ASIL), components have to demonstrate compliance with the ISO 26262 standard. But there is also the possibility of integrating non-ISO 26262-compliant parts into automotive safety applications. With the now well-defined Clause 8-13 in ISO 26262:2018, the integration of non-ISO 26262-compliant products is far more straightforward than before. This opportunity is addressed by Infineon's PRO-SIL™ ISO 26262-ready products, which complement the existing ISO 26262-compliant products.
Functional safety (FuSa) is an essential part of dependable electronics, and Infineon automotive products are designed to support automated driving to the highest levels. For easy identification of components developed for safety-related systems, Infineon has introduced three different brandings: PRO-SIL™, PRO-SIL™ ISO 26262-ready and PRO-SIL™ ISO 26262-compliant.

2. Infineon's automotive product classification

All Infineon automotive products are based on mature and qualified development and production processes conforming with IATF 16949. All products are qualified against AEC standards such as AEC-Q100, and fulfil relevant industry standards which can include ISO 26262 and others.
There are four product designations within the Infineon product portfolio, each of which refers to different safety conformity levels. The levels build on each other, but only PRO-SIL™ ISO 26262-compliant parts are classified via the corresponding ASIL.

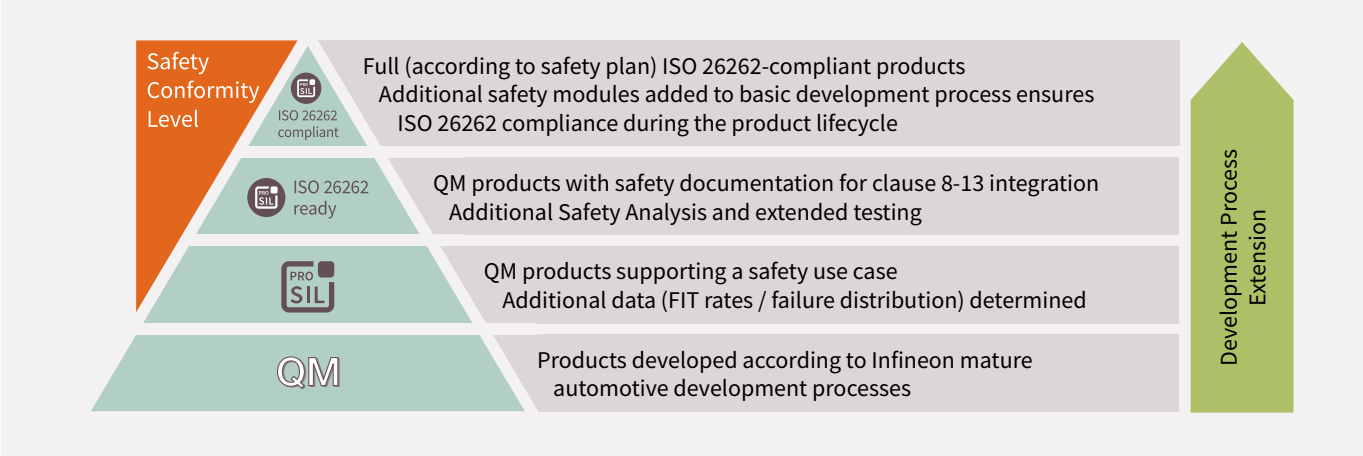


Figure 1: Infineon FuSa-relevant products are categorized by safety conformity level

At the bottom of the pyramid are QM parts which do not have any safety classification. The higher levels are then grouped into three categories under the PRO-SIL™ branding. This grouping allows customers to find the correct product for their application needs and minimizes their efforts when it comes to integrating an Infineon product into their ISO 26262 compliant safety system.

Product classification	IATF 16949 conform (Infineon Development Process)	Conformity with ISO 26262 Standard	ISO 26262 Clause 8-13 Class I possible	ISO 26262 Clause 8-13 Class II possible	ISO 26262 Clause 8-14 possible
QM	X		Customer specific		
QM with PRO-SIL™	X		X		
ISO 26262-ready	X			X	X
ISO 26262-compliant	X	X			

Figure 2: Product classifications versus conformity with standards

QM products

Infineon's QM products are the basis of all Infineon automotive safety classified products. QM products do not carry any further classification (such as the ASIL levels applied to ISO 26262-classified products), but they are developed according to Infineon's standardized internal research and development processes.
All products fulfil the highest quality standards for automotive applications and are qualified according to AEC Q10x. Infineon automotive quality stands for high reliability and robust designs beyond the industry standard.

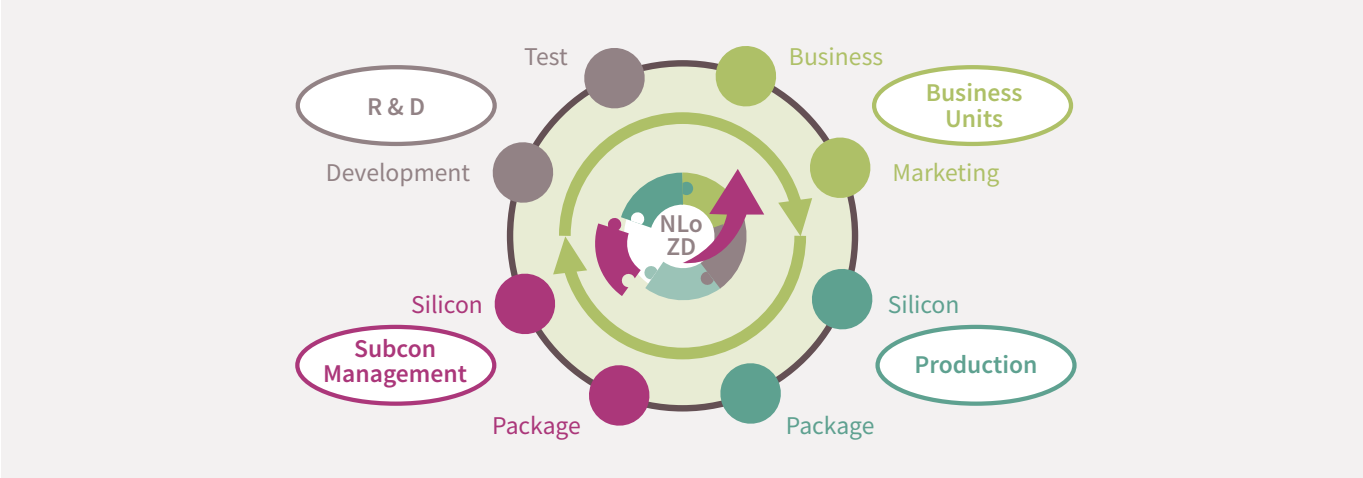


Figure 3: Infineon's NLoZD extends throughout the business

All of this is encompassed in Infineon's Next Level of Zero Defect (NLoZD) initiative that extends throughout the business, covering research and development, production, subcontractor management, and the business units. This leads to excellent ppb (parts per billion) rates as well as negligible 0 km failures.

PRO-SIL™ products

Infineon's PRO-SIL™ brand was established in 2007 to address the emerging need for functional safety semiconductors in automotive applications. Now, the PRO-SIL™ brand is a designator for Infineon's automotive safety-related products.

PRO-SIL™ products do not carry any further classification. Essentially, these are QM products (not ISO 26262 compliant) that may support a safety use case. They have undergone specific assessments at Infineon for customer use in safety-related applications and, as a result, additional data (such as FIT rates/optional failure distribution) along with data sheets and application notes have been determined and made available for customer use. The supporting documentation and information allow for efficient integration into ISO 26262-classified applications according to ISO 26262-8:2018 clause 13 class I hardware elements.

PRO-SIL™ ISO 26262-ready

ISO 26262 ready

The PRO-SIL™ ISO 26262-ready marking designates QM products that can – with additional analysis and evaluation support from Infineon – be integrated into a customer's ISO 26262 compliant, safety-related application, even though they have not been designed or developed according to the ISO 26262 standards.

The requirements specified in ISO 26262:2018 clauses 8-13 and 8-14 may be applied by customers to ensure that the device's functional behavior is adequate to meet the allocated safety requirements for the application level. In general, PRO-SIL™ ISO 26262-ready parts support ISO 262626:2018 clause 8-13 class II hardware evaluation.

Infineon provides a Safety Application Note (SAN) for PRO-SIL™ ISO 26262-ready devices that is designed to aid the customer through the evaluation process. This important document also contains valuable information to support the integration of the component into the customer's safety-related system. Although it remains the customer's responsibility to evaluate whether the product details are suitable and sufficient to support the integration within an ISO 26262 compliant system, the information provided in the SAN will significantly reduce the required effort.

The evaluation process for an PRO-SIL™ ISO 26262-ready product in a functional safety application can be subdivided into different phases (see figure 4).

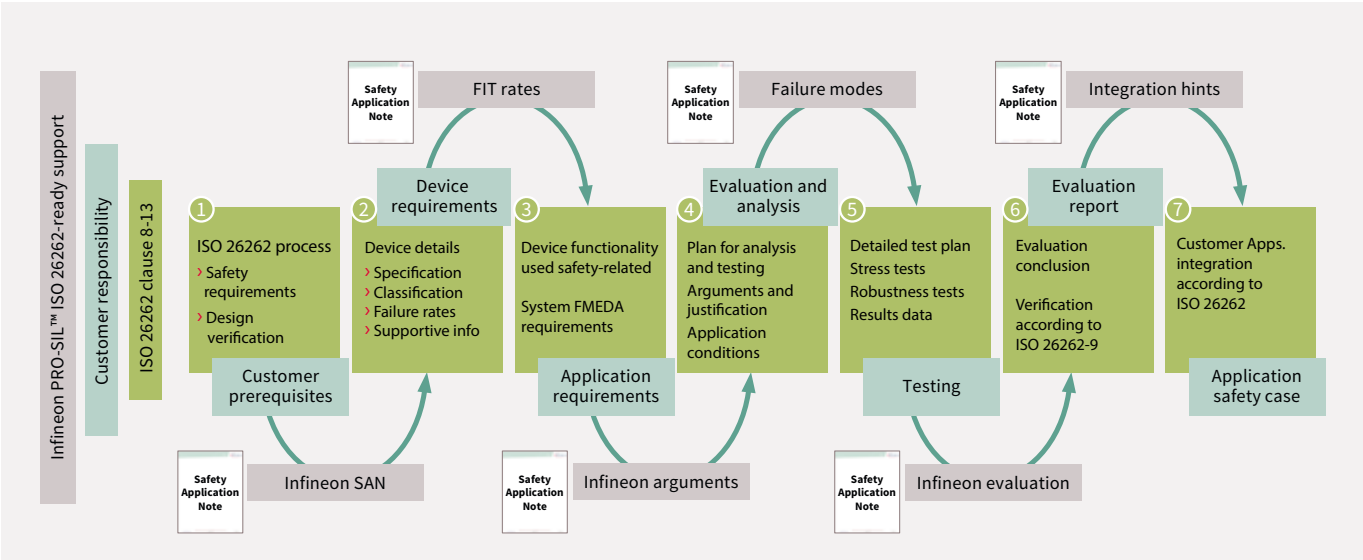


Figure 4: Example flowchart for clause 8-13 hardware evaluation with PRO-SIL™ ISO 26262-ready product

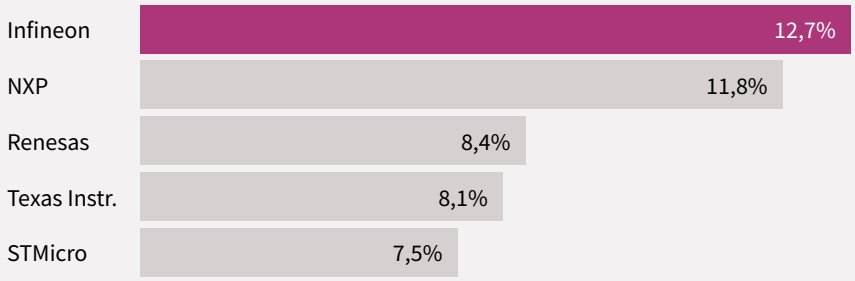
Starting with the customer's prerequisites for the relevant application and the Infineon product's capabilities as described in the SAN, the relevant device functionality for the application can be assessed with regards to implementation details and specific failure rates (FIT - Failure in Time).
The SAN contains supporting details for analysis of the device and, based upon device failure modes, the customer is able to perform stress testing under application-specific environmental conditions. In the end, the SAN helps the customer to prepare their system-level safety evaluation report (application safety case).

PRO-SIL™ ISO 26262-compliant

ISO 26262 compliant

PRO-SIL™ ISO 26262-compliant devices meet all relevant requirements for semiconductors as defined in the ISO 26262 series of standards for automotive functional safety. These devices have been developed according to a project-specific safety plan, following the Infineon V–model development lifecycle which encompasses all activities and relevant work products required under ISO 26262.
A safety manual is provided to customers for PRO-SIL™ ISO 26262-compliant devices. This manual includes all safety-related technical details which are needed for correct integration into safety-related applications such as safety requirements fulfilled by the device, mandatory integration measures (AoU – Assumptions of Use), and results of safety analysis that has been performed. An optional FMEDA may be delivered in agreement with Infineon.
Infineon use an independent functional safety management organization to support the internal PRO-SIL™ ISO 26262-compliant lifecycle and to assess whether all objectives defined by the ISO 26262 standard have been reached and are supported by sufficient evidence. A safety case report may be delivered in agreement with Infineon for compliance argumentation in relation to customer applications.

Infineon automotive product lifecycle ensures a competitive product portfolio



Strategy Analytics – March 2022. Automotive Semiconductor Vendor Market Shares

Figure 5: Automotive semiconductors (2021 total market: $46.7bn)

As an established leader in components for automotive applications, Infineon offers the industry's most comprehensive and innovative portfolio of power semiconductors, sensors, microcontrollers, memories, and automotive communication devices. These premium products, along with Infineon's system knowledge and passion for innovation and quality, enable a leadership position in terms of technology and customer relationships.
A well-defined and established process controls all Infineon product development, including the development of products for demanding automotive applications. Combining this with stringent internal quality standards and compliance with relevant industry standards ensures that all Infineon products deliver the dependability that automakers and the car-buying public demand.

SGS TÜV SAAR FUNKTIONALE SICHERHEIT GEPRÜFT FUNCTIONAL SAFETY APPROVED

The automotive development and production process is certified to IATF 16949 and has recently been certified to ISO 26262 as well. This ensures ISO 26262 compliance by process adherence in current and upcoming development projects. Infineon's aftersales support helps our customers to integrate Infineon automotive products and ensures product compliance with ISO 26262 over the whole product lifecycle. Widespread adoption of automated driving hinges above all on driver trust. Our holistic approach to functional safety, our passion for quality translate into dependable electronics with the power to inspire this trust. It's safe to say that we provide the functional safety needed for the dependable systems of today and tomorrow.

3. Automotive Power Distribution System (PDS) and PRO-SIL™ ISO 26262-ready

One of the significant trends within automotive power distribution system design is the replacement of mechanical and electromechanical devices such as fuses and relays with semiconductor components. Infineon's PRO-SIL™ ISO 26262-ready intelligent power devices support the functional safety requirements arising from this trend.
The major drivers for this change are reduction of power losses, PWM operation with more sophisticated control schemes, implementation of advanced diagnostics and safety concepts, and enablement of decentralized power distribution architectures to simplify wire harness complexity. In comparison with a relay-based system that requires a coil driver, fuse, relay coil, and relay contact, semiconductors offer higher current density in smaller footprints and often reduce power losses by as much as a factor of seven.

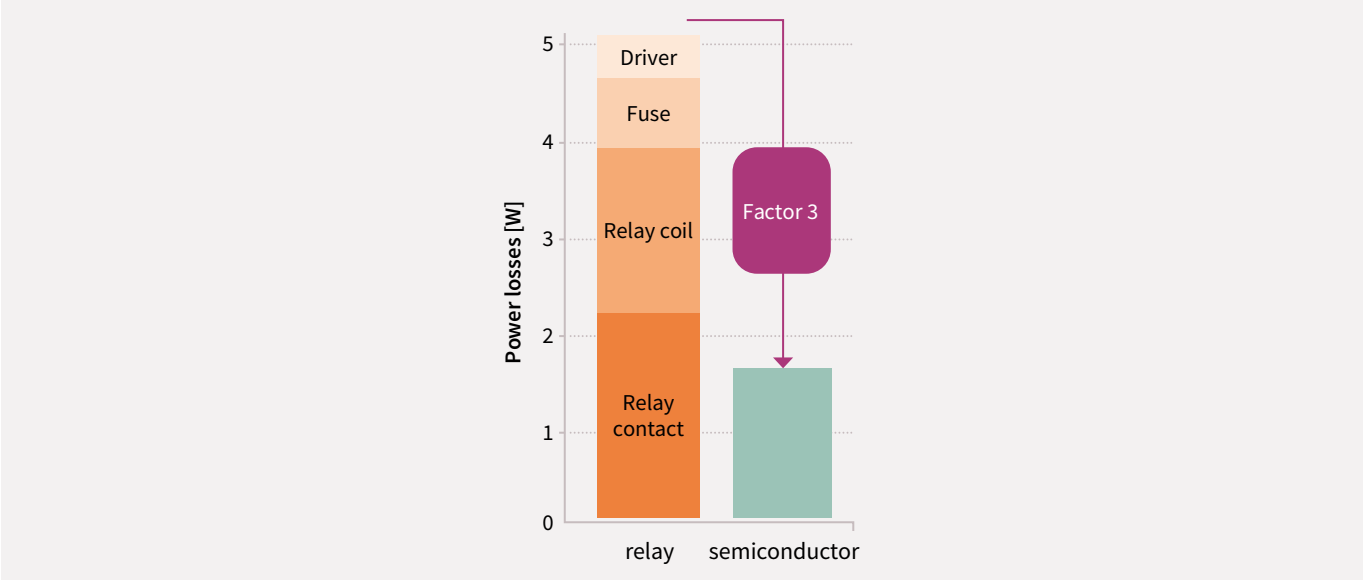


Figure 6: Semiconductors significantly reduce power losses compared with electromechanical devices

In fact, Infineon offers the most comprehensive portfolio of intelligent power devices, thereby enabling customers to safely make this important transition.

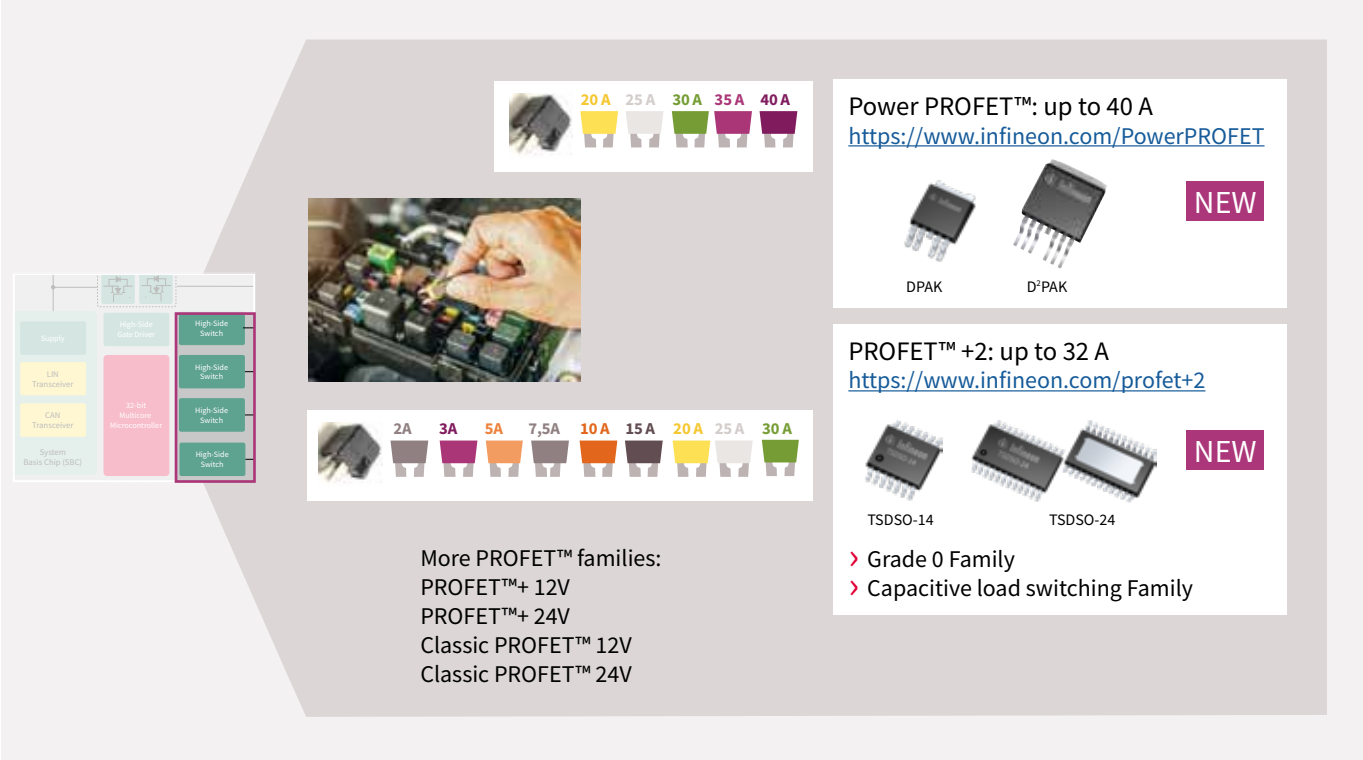


Figure 7: Infineon has the most comprehensive portfolio of intelligent power devices

While the benefits of fuse and relay replacement are somewhat obvious, as mentioned earlier, the move to greater automation in vehicles is driving change in power architectures and further necessitating the elimination of fuses and relays.

At the heart of this are the Automated Driver Assistance Systems (ADAS) and Automated Driving (AD) technologies. While these systems are required to be wholly dependable in terms of sensors, computing, and actuators, the same requirements must apply to the power distribution system upon which they rely.

The required level of dependability of the PDS is related to the SAE level of the vehicle's systems and, specifically, the level to which the driver can be considered a 'fallback' in the case of a system failure (including a PDS failure). As the autonomy level increases, reliance on the driver as a fallback decreases. At low SAE autonomy levels (e.g. level 1-2), it is often sufficient to ensure that systems enter a safe state in the case of component failure – this is called a fail-safe architecture. As the autonomy level increases (e.g. SAE level 2+), critical system operations (including PDS) must be maintained even in the event of a component failure. Such systems are termed fail-operational (FO). Once SAE levels 4-5 are reached, the vehicle systems must operate under all conditions – as there is no driver fallback assumed. This means: dependable operation even after a first failure, also called high availability.

The key elements of an FO PDS can be seen in the diagram showing the various ASIL levels required.

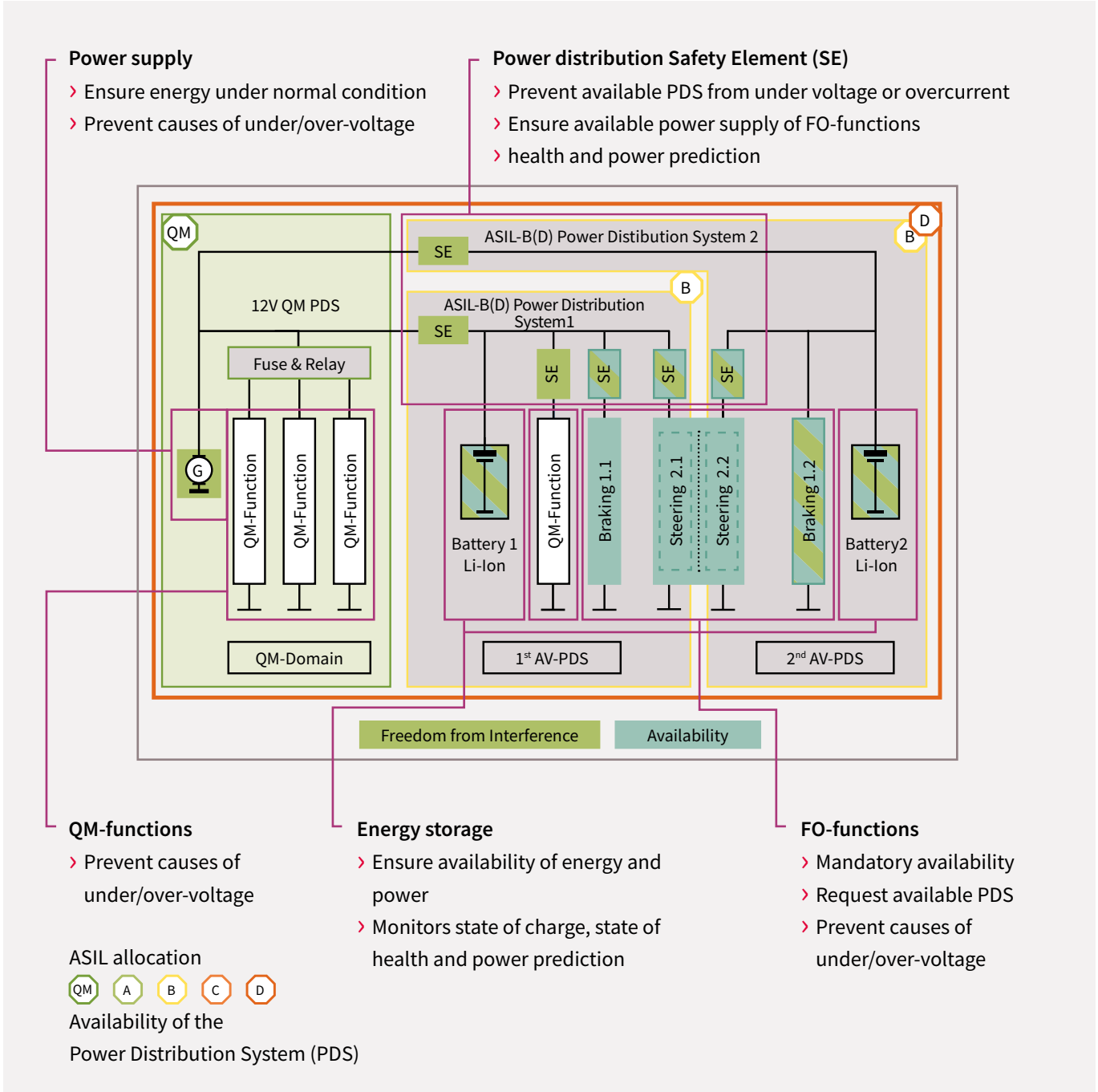


Figure 8: Higher levels of automation demand fail-operational PDSs

Key features within the Safety Element (SE) functions include capacitive charging, wire protection, and fast failure isolation. Fast failure isolation is critical to ensure the freedom from interference throughout the system, and is required to comply with ISO 16750-2 and any relevant OEM specifications. The wire protection requires fuses to be replaced with resettable protection that is available in all operating modes and does not rely on microcontroller support.

4. Infineon products for PDS design

The Infineon PRO-SIL™ product portfolio contains a range of components that are ideally suited for use in the design of FO PDSs. For relay and fuse replacement, the PROFET™ family offers a range of highly scalable power switch ICs grouped into two key families:

› Power PROFET™ is Infineon's smart high-side switches family for nominal currents up to 40 A. These products are designed to drive high currents where high energy capability and challenging current profiles are required, such as DC motor inrush at start-up.

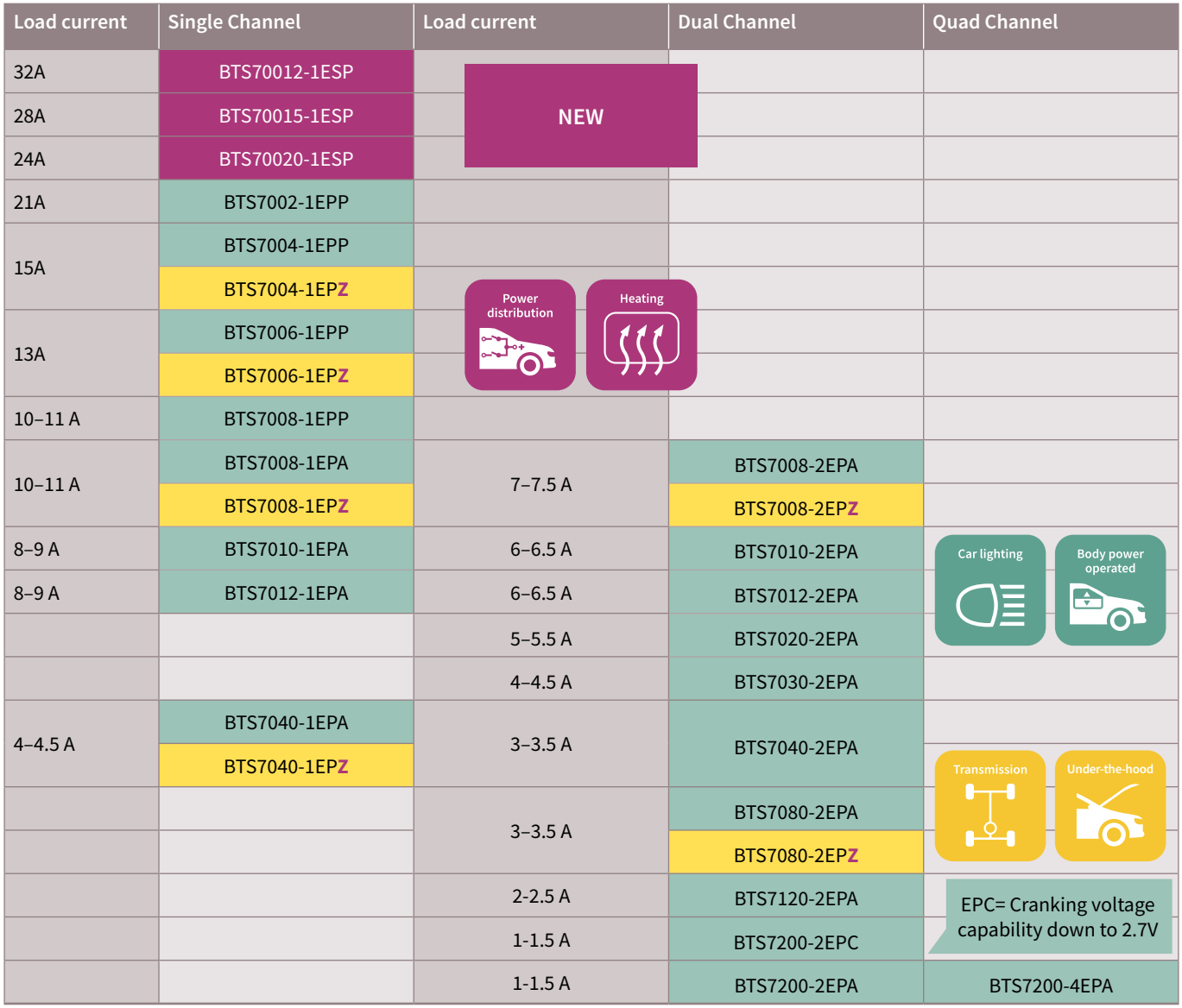
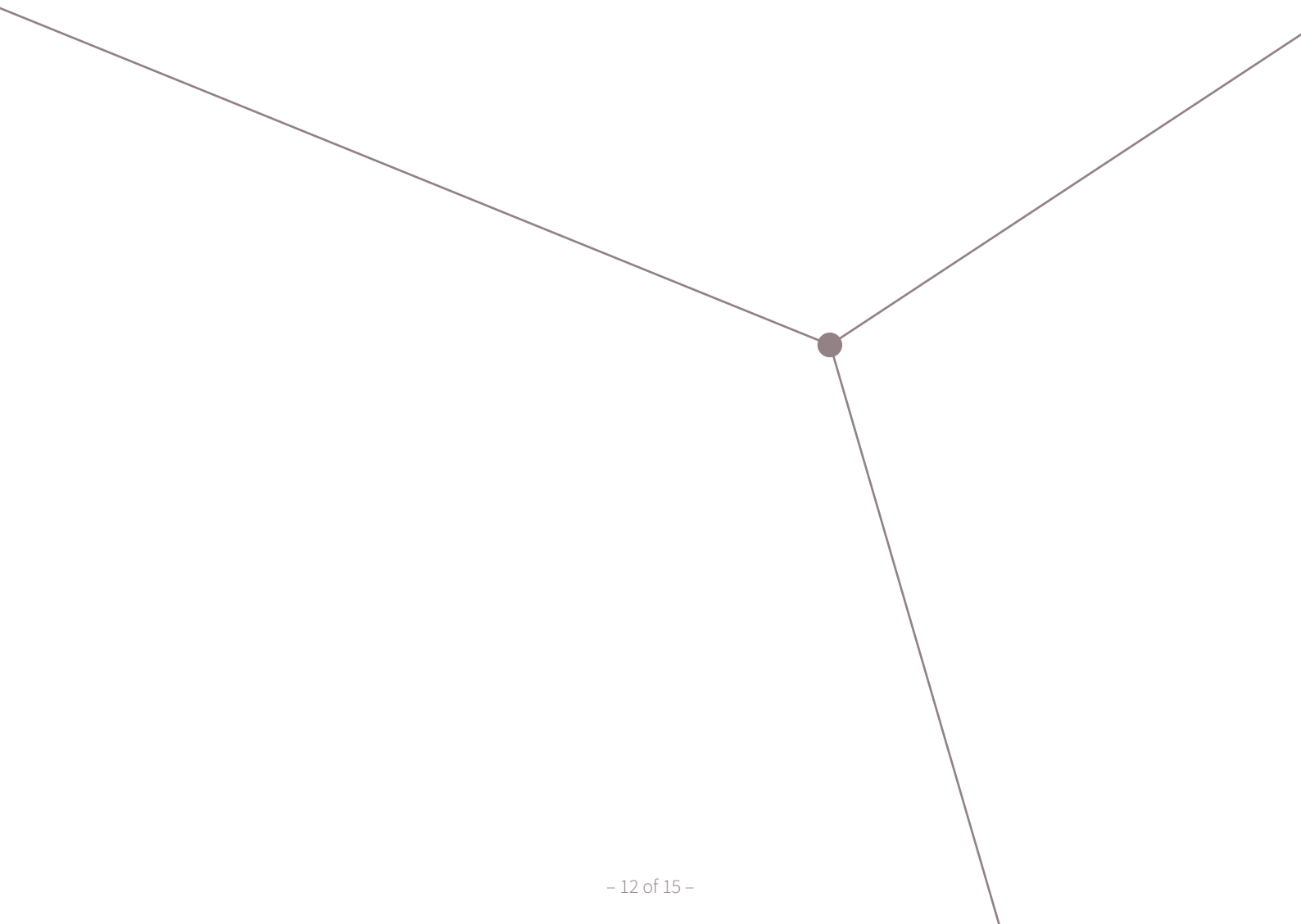


Figure 9: Products from the Infineon PROFET™+2

› PROFET™+2, the newest family of smart high-side switches, is rated for nominal currents up to approximately 30 A, offering single-, dual- and four-channel devices with state-of-the-art diagnostic and protection features. The PROFET™+2 family delivers outstanding energy efficiency with reduced current consumption, state-of-the-art current sense accuracy, benchmark low cranking voltage capability, and EMC-optimization for faster switching.
The PROFET™+2 family also includes some high-temperature Grade 0 variants, which allow operation at higher ambient temperatures, and provides benefits for extended lifetime mission profiles. These devices are qualified beyond the requirements of AEC-Q100 to ensure that they easily meet or exceed OEM criteria.

Microcontroller functionality is provided by the 32-bit TRAVEO™ II microcontroller. Based on ARM® technology for automotive use, TRAVEO™ devices offer cutting-edge performance, safety, and security. The TRAVEO™ II CYT4BF delivers enhanced performance up to 1500 DMIPS and a high-performance CPU operating at speeds up to 350 MHz. Depending on module complexity and safety requirements, AURIX™ microcontrollers with ASIL-D capability and higher DMIPS ratings may also be used.



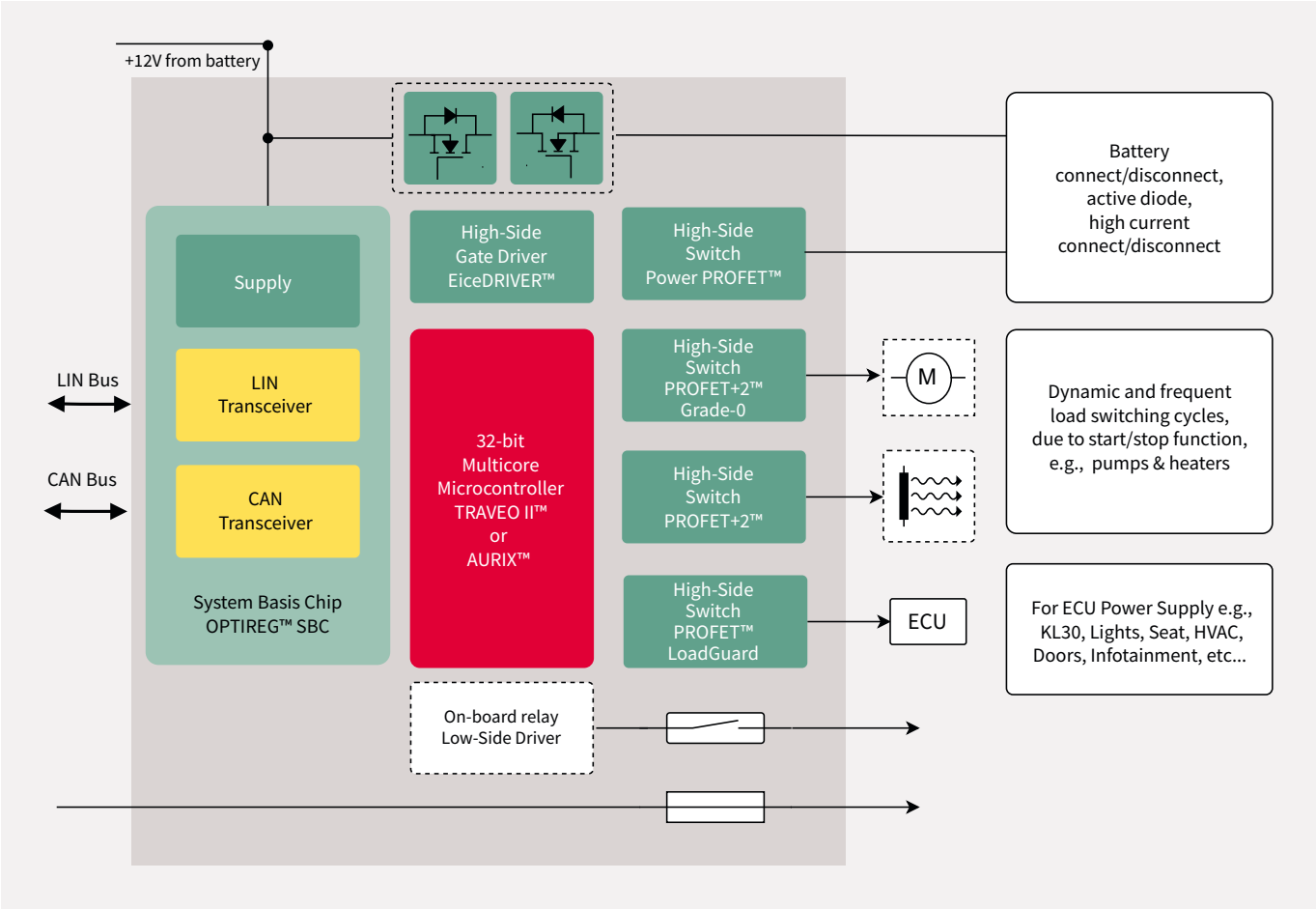
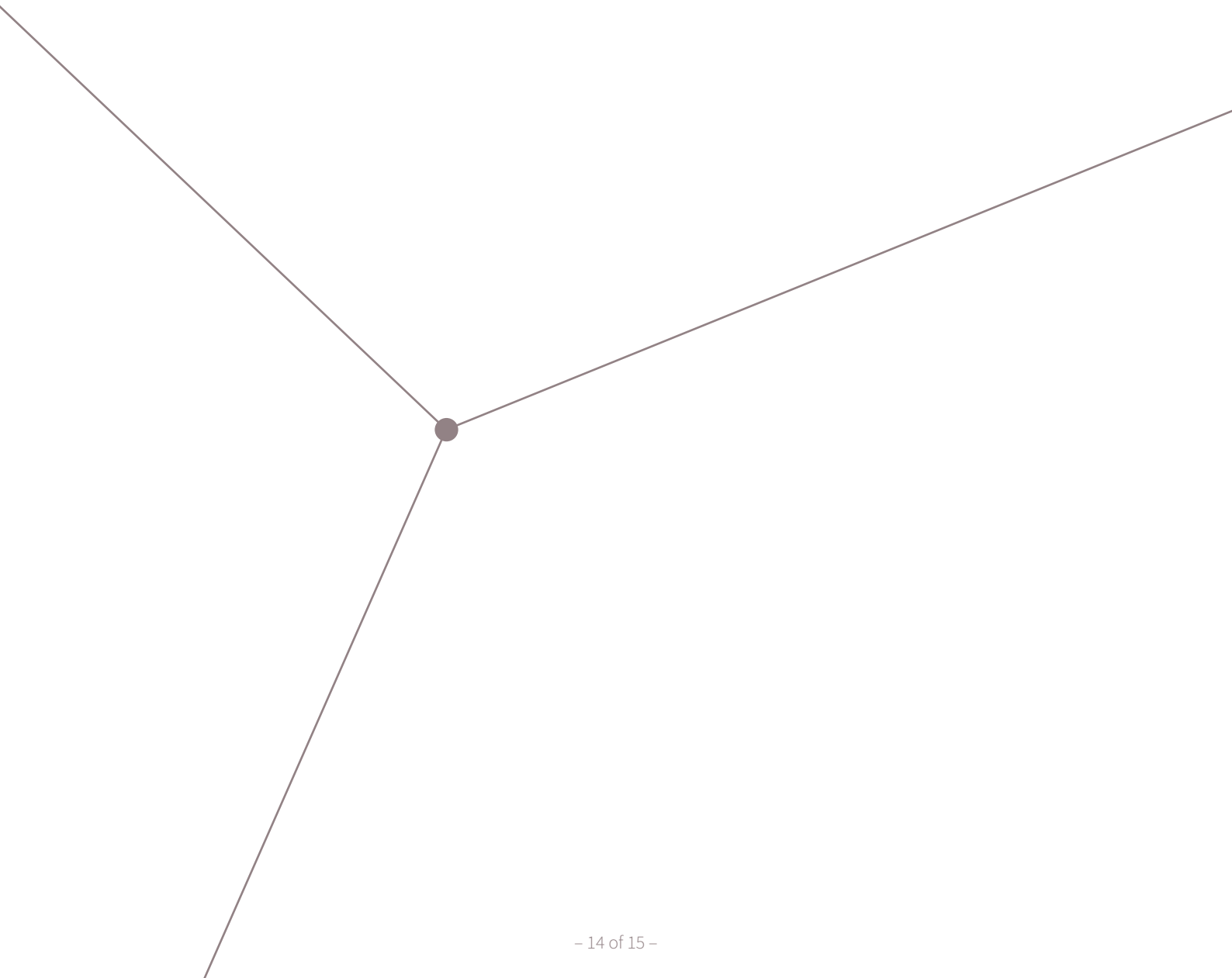


Figure 10: Typical power distribution module block diagram

For a higher level of integration, Infineon's System Basis Chips (SBC) combine communication and power supply in a single device and are highly recommended for power distribution module applications. The OPTIREG™ SBC family contains a power supply, state machine with diagnostic feedback and supervisory features, as well as dedicated low quiescent current. These SBCs all offer LIN, CAN, and/or CAN-FD communication interfaces.
The SBC portfolio can be used to implement many automotive-specific power supply product features such as reset, watchdog, and early warning, helping to solve almost all design challenges in the power distribution module application. The Infineon Lite SBCs offer a smaller, lower-cost solution, while the Mid-Range+ SBC family provides additional interfaces should they be needed. For higher-power applications, the DCDC+ SBC should be used with switched mode power supplies instead of LDOs.

Summary

Automobiles now incorporate technology to provide far greater driver assistance through ADAS than ever before and they are rapidly moving towards fully AD, eventually in all driving conditions. As greater reliance is placed upon the vehicle's systems by the driver and occupants, ever-greater consideration is also being placed on the subject of safety.
Much of automotive safety is built around the automotive functional safety standard ISO 26262. In order to fulfil the objectives of this standard, stringent processes have to be followed and, ideally, PRO-SIL™ ISO-26262 compliant components should be used to reduce the workload on the designer/integrator/customer.



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