Advanced technologies drive greater reliability, efficiency and safety in CAV vehicles

Integrated technology solutions and an integrated supply chain deliver innovative automation

Vincent Usseglio, Global Distribution Marketing Manager, Infineon Technologies
Frank-Steffen Russ, Director Vertical Segment Automotive & HiRel EMEA, EBV Elektronik
Florian Suessmair, Manager Microcontroller, Infineon Technologies

Abstract

Commercial, Construction and Agricultural vehicles (CAV) have a huge impact on the world we live in and our daily lives. They help to grow the crops that feed us, they deliver that food and other products that we need, and they build the houses, offices and factories in which we live and work.

When considering automotive technology, understandably a lot of the focus has been on cars (passenger vehicles), but the CAV sector is incredibly important and has been undergoing its own technology revolution to deliver greater reliability, efficiency and safety.

In this white paper, Infineon Technologies and EBV look at general industry trends and the growing need for reliable semiconductor solutions with long-term availability within the CAV market. The paper will look at some of the latest product innovations as well as discuss how advanced design tools and an integrated supply chain helps designers bring better products to market faster.

Table of contents

1 CAV Megatrends

The CAV market is driven by the need to increase profitability for vehicle manufacturers as well as operators. The approach to this goal is heavily technology-driven and, in many ways, has strong similarities with the trends that can be observed in passenger vehicles.

There are three main thrusts within the CAV market; Fuel efficiency, Safety and ADAS and Connectivity. Each of these addresses different aspects of the challenge, yet they all combine to deliver higher levels of operational efficiency, productivity, reliability, security and, therefore, operator profitability.

Powertrain electrification is delivering many benefits within the CAV market. Hybrid and / or fully electric powertrains increase fuel economy or even eliminate fossil fuel usage entirely. Additionally, this allows material handling vehicles such as forklifts to operate indoors with no health risk from fumes. Similarly, electric power in busses is a major contributor to cleaner cities.

Beyond the powertrain, hydraulic systems are being replaced with electric actuators. Not only are these electric actuators easier to install, they are more accurate, more reliable and more environmentally friendly. They are also generally smaller and lighter than the hydraulic systems that they replace bringing further benefits to CAV designers and operators.

Figure 1: The CAV market is focused on efficiency, safety and connectivity

Efficiency is further enhanced by technologies such as energy recuperation, where the energy generated during braking is returned to the battery, thereby increasing range and overall productivity. This is simply not possible with internal combustion engines.

Safety is improved by the introduction of Advanced Driver Assistance Systems (ADAS) similar to those found in passenger vehicles. At the heart of this is 'sensor fusion', where sensors combine to provide better environmental awareness and data redundancy that eliminates errors that could lead to accidents.

CAV are becoming more connected, both to the infrastructure around them ('Vehicle to Infrastructure' - V2I) and to each other ('Vehicle to Vehicle' - V2V). This gives the operators unprecedented levels of data monitoring so they can hone their operations to reach the utmost efficiency.

Manufacturers of CAV are faced with a number of challenges as result of these trends. Significant levels of energy have to be stored and transmitted efficiently, and increasingly stringent legislation demands compliance with ASIL standards. Also, the addition of connectivity means that IT security is now a concern with CAV – in some cases, not only could the equipment be compromised by malicious third parties but there is also a possibility that the data and intellectual property stored inside them could be stolen or manipulated. As a result CAV manufacturers are seeking out and implementing secure architectures to address any potential security issues.

2 The Market for CAV

According to a Q4 2016 survey by LMC Truck Production, the global market for trucks with a gross vehicle weight greater than six tons is currently 2.7 million vehicles per year. This is predicted to increase at an average CAGR of 4.1% until 2023. China is already the largest single market and this will continue, albeit with lower than average growth due to partial market saturation.

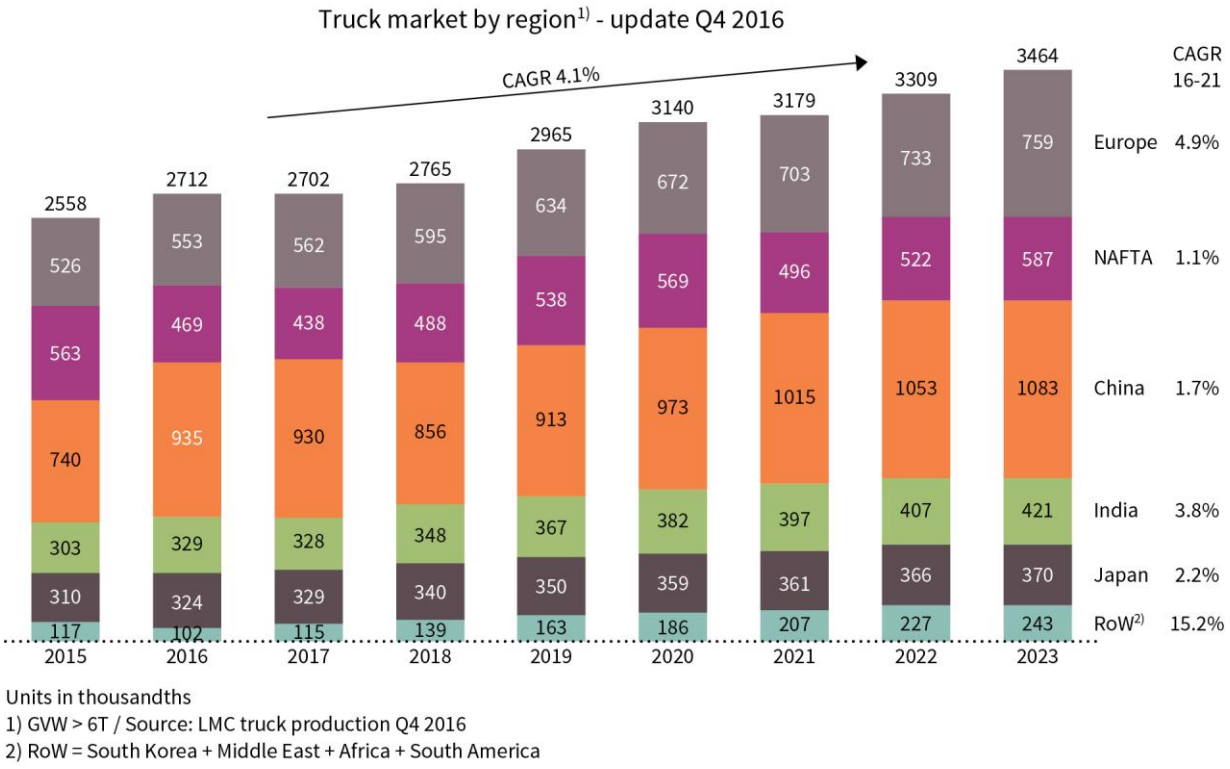

Figure 2: Predictions indicate continued strong growth for CAV

Europe will grow faster than average, confirming its position as the second-largest global market after China. The NAFTA region received a recent boost as operators pre-bought vehicles before implementation of new US Environmental Protection Agency (EPA) emission legislation.

The market for semiconductors within trucks currently stands at approximately $1.5Bn and, not surprisingly, shows similar regional trends. However, the market shows considerably stronger growth at an estimated 9.5% CAGR - this is clearly due to significantly increasing semiconductor content in trucks and other CAV as a result of the on-going electrification.

3 Sense, Think and Act

Increasing levels of electrification and automation are requiring CAV to assume many functions previously performed by their human driver. When we as humans drive a vehicle, without necessarily realizing it, we continuously sense the immediate environment, we process that information and then we take whatever action is necessary.

In CAV, this three-step process is performed by three separate advanced technologies. Arrays of sensors combine to sense the environment. These fused sensors provide data to a new generation of high performance, highly integrated and highly secure microcontrollers that think. A broad range of power semiconductor MOSFETs and drivers act by taking control signals from the microcontroller and powering the electronic actuators.

3.1 Sensing

Vehicles have had sensors for almost as long as vehicles have existed. In the early days these have been simple sensors that have measured discrete functions such as engine parameters, fuel levels, etc...

As in-vehicle sensing proliferated and appeared in safety-critical areas (e.g. steering), more reliance was put upon the sensors and the consequences of erroneous information or sensor failure became greater. The latest CAV are incorporating 'sensor fusion' where arrays of sensors combine to provide different ways of sensing the same parameter, thereby allowing the processor to detect and react to discrepancies, often by shutting down systems until the fault is resolved.

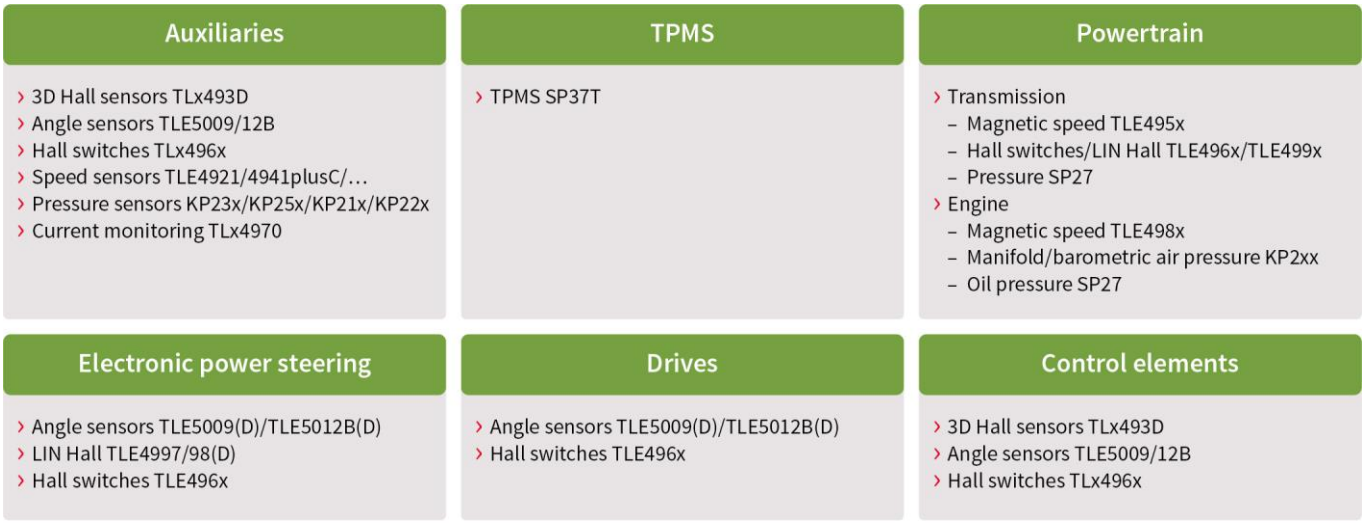

Figure 3: Sensor technologies are proliferating throughout CAV

One sensing solution that is fundamental to safety within CAV is 24 GHz short-range radar that is able to detect objects in the path of the vehicle, for example. At the heart of this solution is the 32-bit TriCore™ TC264DA microcontroller that is part of the AURIX™ family. The highly advanced and heavily integrated processor features two TriCore™ DSP cores and on-board Flash, EEPROM and RAM.

The TC264DA is heavily optimized for radar applications and contains dedicated radar peripherals, including an FFT signal processing accelerator with hardware windowing, as well as multiple high-precision timers. There are a total of four 12-bit SAR ADCs for radar signal acquisition, and a 16-bit parallel interface allows easy connection to external ADCs.

Multiple communication protocols are built in, including FlexRay, CAN, CAN FD, LIN and SPI, both for in-vehicle communication as well as inter-processor communication. A 2.5 GHz high-speed trace port enables real time vision and radar data tracking.

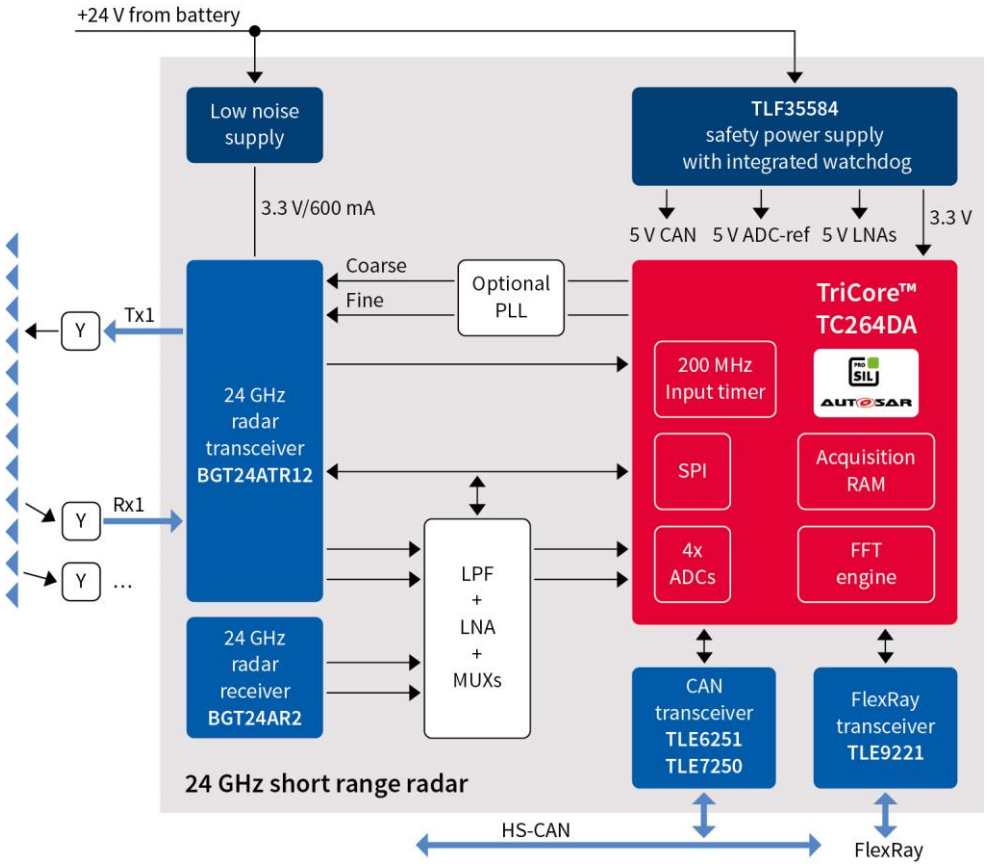

Figure 4: Block diagram of a 24 GHz radar system for CAV

As part of the AURIX™ family, the TC264DA is built around a comprehensive and innovative safety feature set. A diverse Lockstep Core reduces development effort by replacing a dual channel (two micro) system, with a single AURIX™ processor while access permission system and safety management units make the microcontroller ideal for safety-critical applications such as 24 GHz radar.

The architecture ensures ISO 26262 compliance, supporting safety requirements up to ASIL-D.

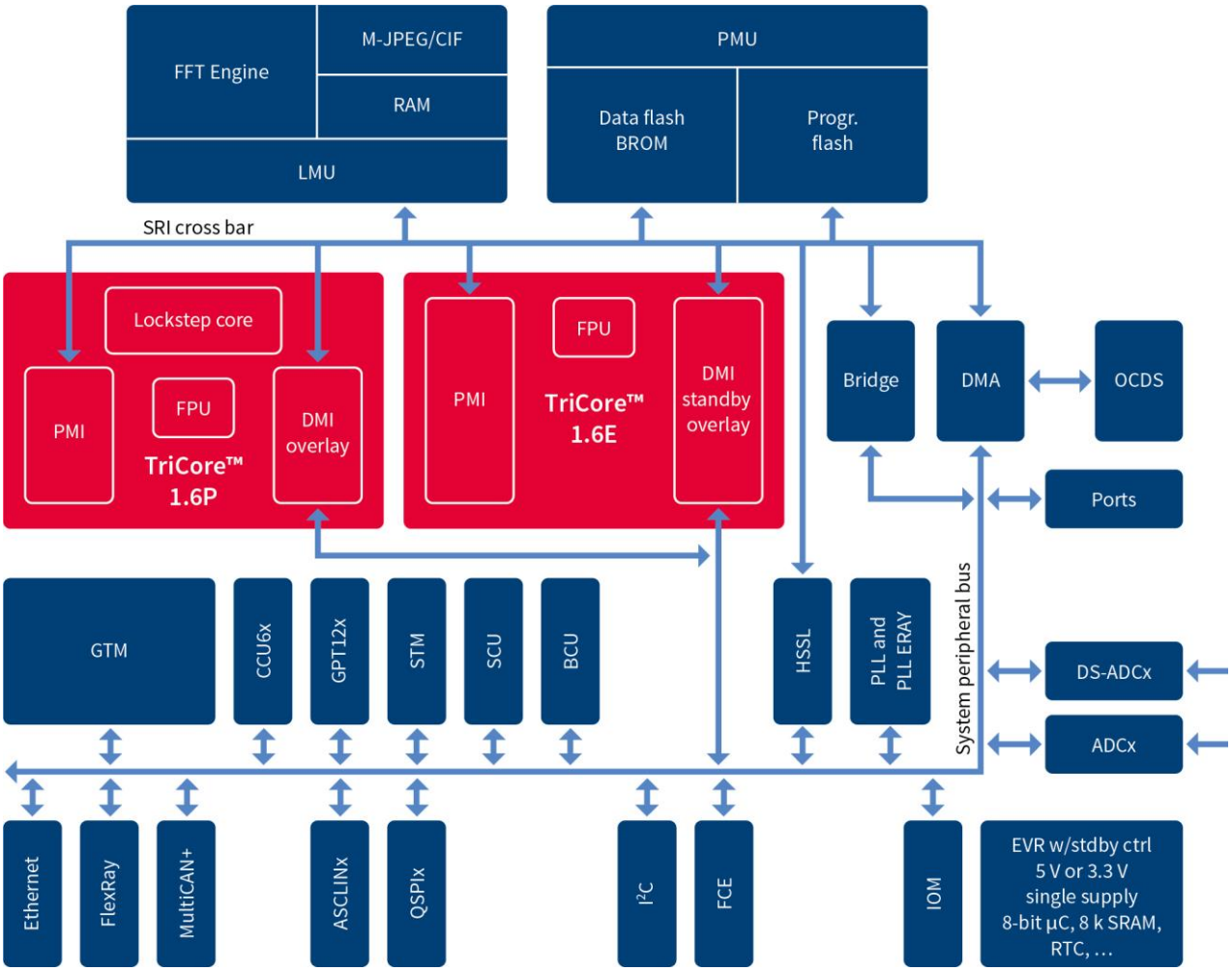

Figure 5: Functional block diagram of the TC246DA AURIX™ microcontroller

The TLF35584 safety power supply does much more than provide pre- and post-regulation for a multi-rail system power supply. As an integral part of the overall safety concept, the device includes system watchdogs, error monitoring, voltage monitoring and a built in self-test thereby ensuring the safe operation of the 24GHz radar at all times.

3.2 Thinking

Within CAV applications, AURIX™ provides both system performance and safety within key applications such as braking, engine control, convenience and comfort features and universal I/O. AURIX™ processors are based upon multi-core technology and include dedicated hardware

accelerators and floating-point units that deliver the performance required in today's highly demanding CAV applications.

For OEMs in the CAV market, scalability is important as they seek common designs throughout a vehicle range, including flexible and cost-effective support of optional features. The ability to scale designs also delivers long-term stability, as future generation designs with extended feature sets can be built upon an existing platform, thereby reducing design time and risk. AURIX™ delivers the flexibility that designers seek with fully scalable hardware that includes devices with up to 3 TriCore™ DSP cores running at up to 300 MHz, along with on-board Flash memory and RAM.

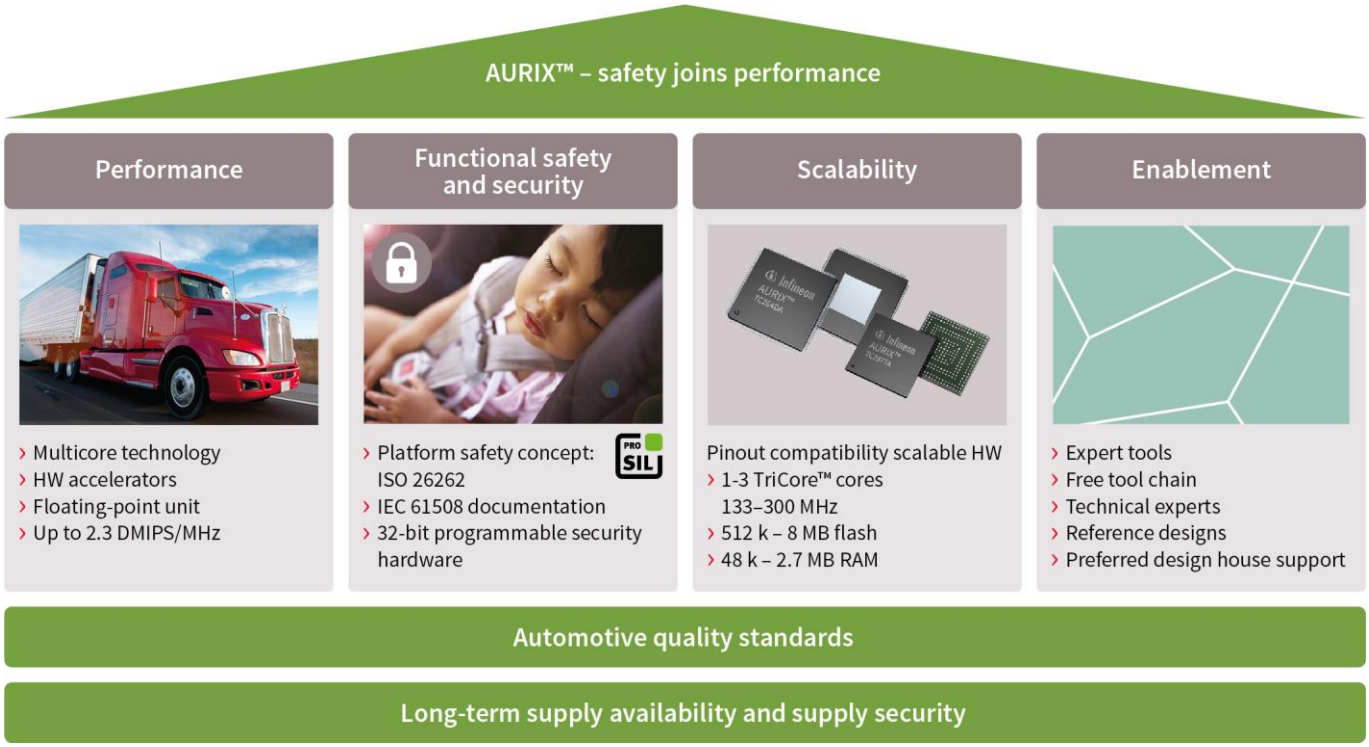

Figure 6: AURIX™ brings together safety and performance

The connected nature of modern CAV means that key vehicle functions such as steering, braking or sensing are exposed to the possibility of unauthorised remote access with potentially catastrophic results. AURIX™ contains a Hardware Security Module (HSM) that delivers high levels of security through the creation of a Trusted Execution Environment that contains a separated MCU. The interior of the HSM is protected from access by all other bus masters, meaning that this solution delivers high levels of security in applications such as SOTA.

The development of the AURIX™ safety concept was based on the stringent needs of the automotive safety standard, ISO26262. Infineon provides comprehensive Functional Safety support including tools, reference designs, expertise and a network of preferred design houses.

The available documentation to support functional safety design up to ASIL-D / SIL 3 includes a safety manual, safety case and FMEDA analysis that meet the needs of ISO26262 and the wider industrial standard IEC61508.

With the single safety concept, high performance microcontroller functionality and comprehensive safety design support, AURIX™ allows CAV OEMs to reach their safety goals with ease.

3.3 Acting

Once the sensor data has been analyzed and the thinking is complete, then the CAV needs to act. Until recently this would have been through hydraulic systems, but modern CAV incorporate electrical actuators that are more accurate, reliable and environmentally friendly than the systems that they replace.

Nowadays, acting within CAV is based around power control and invariably involves power conditioning and switching. There is a fundamental shift in the power architecture within CAV as OEMs seek greater efficiency and reliability. Typical power control architectures in CAV applications include Low-Dropout regulators (LDOs), DC/DC converters and post regulators. Each of these solutions delivers high levels of efficiency, flexibility and reliability.

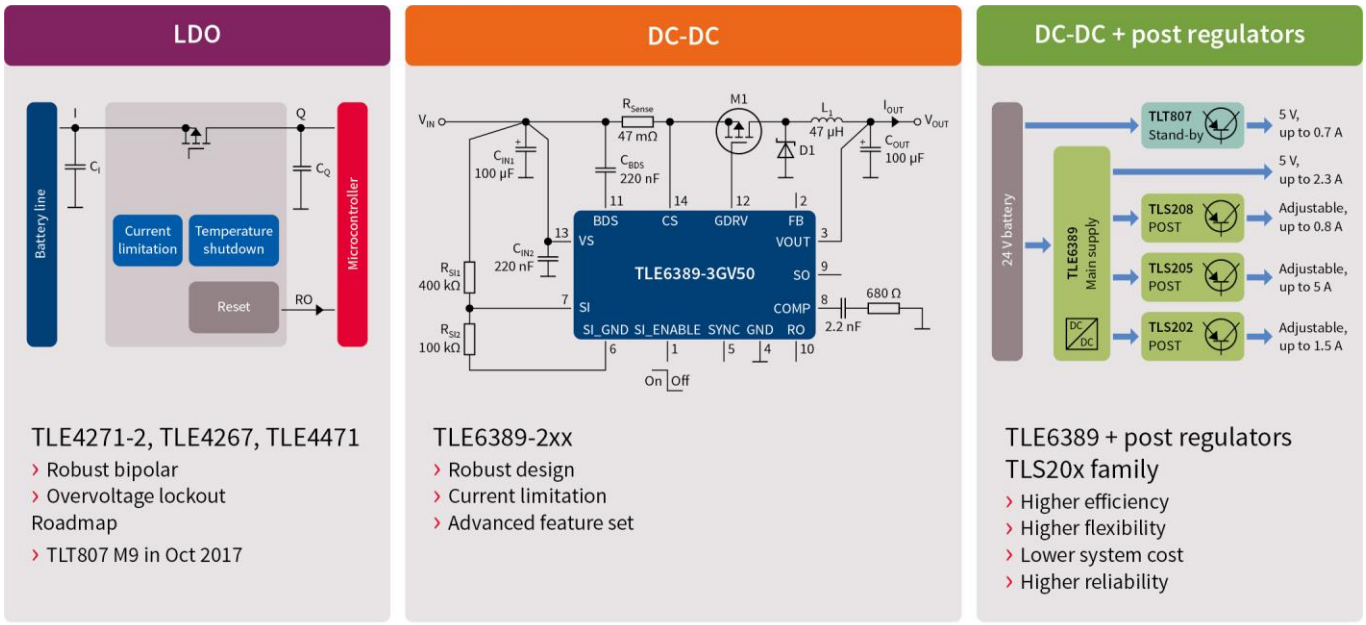

Figure 7: Modern power solutions deliver efficiency, reliability and flexibility

Many electromechanical devices are inherently unreliable and OEMs are resolving these dependability issues by replacing classical relays with semiconductor-based solid state relays (SSR) or semiconductor 'smart switches' such as PROFET™ protected MOSFET devices that allow the driving stage to be

moved from a relay box to another existing ECU, thereby providing simplicity and improving reliability. The PROFET™+ family offers 12 and 24 V pin-to-pin compatibility that fits the CAV market.

Fuses are another area where change is happening rapidly. The centralized fuse box is being replaced with smart Power Distribution Centers (PDCs) that are distributed around the CAV. These PDCs feature automatically resettable solutions such as smart, self-protected semiconductor switches that deliver greater reliability and also significantly reduce the wiring in CAV, bringing weight reductions and cost savings yielding greater efficiency and profitability.

4 Tools to support the design process

Alongside the support offered for the AURIX™ safety requirements, Infineon also provides designers with a plethora of design tools and reference designs that ensure designers can assimilate these new technologies rapidly and confidently, allowing them to deliver prototype designs faster.

One such development platform is for the 24 GHz radar system. The development board is a full sub-system that includes the TC264DA AURIX™ processor and BGT24ATR12 twin MMIC transceiver that is qualified for CAV and automotive applications according to the AEC Q100 standard. The development board also includes all necessary connectivity (e.g. power, CAN bus and Ethernet).

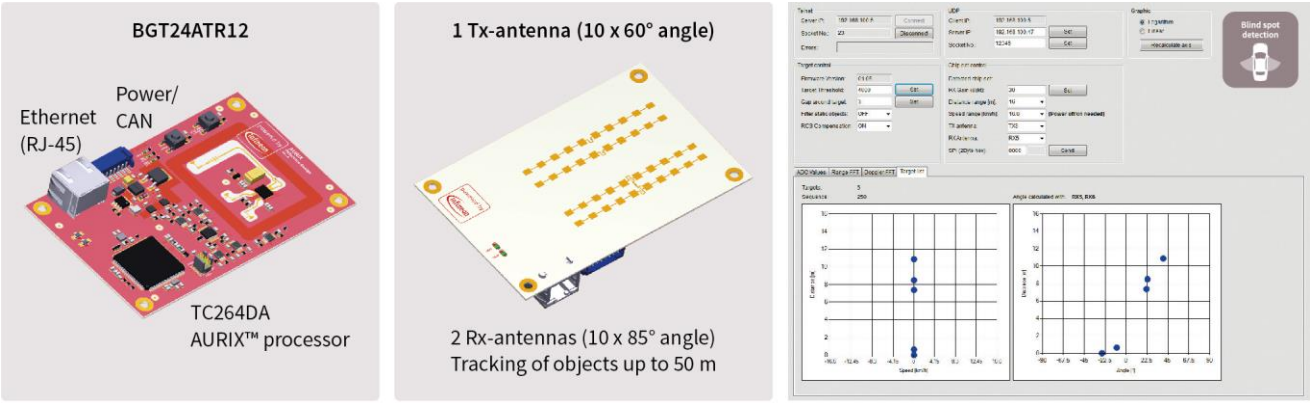

Figure 8: The 24 GHz radar development platform is fully comprehensive

In order to speed up the development process, a board with one transmit antenna and two receive antennae is included. This enables tracking of objects at distances of up to 50m.

Alongside the hardware, the development platform includes substantial documentation that will allow rapid progression from prototype to series production. PCB Gerber files, complete schematics and a comprehensive BOM allow users to understand and replicate the hardware. On the software side, the source code for the AURIX™ processor is included, along with a PC GUI for development purposes.

The comprehensive package also includes a protocol description and a start-up guide as well as access to the functional safety support mentioned earlier.

5 Integrated support for CAV customers

Infineon is a leading semiconductor manufacturer in the worldwide automotive market and has a strong focus on the CAV market as part of its long-term business strategy. While Infineon delivers products that focus on the three primary drivers of innovation, safety and reliability, an integrated distribution channel is needed to ensure broad customer support.

The CAV market is formed from many customer types, with some key OEM as well as customers who prefer to buy direct from the manufacturer. There are also a significant number of customers that appreciate the support that a distribution channel can offer.

EBV is Infineon's partner of choice for the CAV customer base. With their comprehensive European presence and a team of 150 field application engineers that are all trained on Infineon's product range, customers can be assured of high levels of support.

Most customers approach EBV seeking support on just one of the three elements ("Sense, Think, Act"), but through working with EBV's team they discover the benefits of the integrated approach. All customer feedback during these interactions is passed to the Infineon design team who use this valuable 'voice of the customer' to shape future product definitions and design decisions.

6 Summary

The CAV market is showing strong year-on-year growth in terms of the number of vehicles produced. Looking to the semiconductor content flowing into this sector, however, the growth is more significant due to the trend towards increasing electrification. While the CAV sector follows the general automotive market to an extent, there are special needs to be addressed, including higher battery voltages, hydraulic system replacement and the need for long-term availability of products for spares and repair.

In common with all markets, the CAV market is seeking to improve profitability, specifically through greater efficiency, productivity and reliability. Leading semiconductor manufacturers (such as Infineon) are enabling this by providing market leading and fully integrated product offerings that deliver efficiency, security, safety and reliability.

Alongside this, Infineon is creating and delivering comprehensive development platforms that remove risk and accelerate design timescales, as well as working with their preferred distribution partner, EBV, to provide the products and platforms and ensure strong support for all CAV customers.

Published by
Infineon Technologies AG
85579 Neubiberg, Germany

Order Number: B000-H0000-X-X-7600
Date: August 2016

Additional information

For further information on technologies, our products, the application of our products, delivery terms and conditions and/or prices please contact your nearest Infineon Technologies office (www.infineon.com).

Warnings

Due to technical requirements, our products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by us in a written document signed by authorized representatives of Infineon Technologies, our products may not be used in any life endangering applications, including but not limited to medical, nuclear, military, life critical or any other applications where a failure of the product or any consequences of the use thereof can result in personal injury.