Sensor, Power Management, and Bus Solutions as Drivers of Global Megatrends

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> "We have been firmly established as a competent supplier to the automotive industry in the EMEA region for years now."
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> *Stefan Steyerl, Analog Devices*

A large part of in-vehicle innovations to date can be attributed to the use of modern electronics, including semiconductors. Industry experts believe that, in the future, electronic components will be responsible for up to 90% of all vehicle innovations and will likely continue to generate strong growth in the market for automotive semiconductors.

The industry identified the main drivers of growth in the automotive electronics market to be the megatrends of automated driving—that is, automated or autonomous vehicles, electrification of the powertrain, and networking of vehicles with other vehicles and with the infrastructure or their environment, which is also known as connectivity.

For automakers and their suppliers to be able to implement the upcoming vehicle innovations according to global megatrends, and make vehicles even safer and more economical in terms of consumption, more and more semiconductor components are needed for each vehicle. While today's semiconductors are worth, on average, $250 per vehicle, the total semiconductor share in upcoming vehicle generations should reach up to $2000 per vehicle. For automated driving functions, depending on the level (1 to 5), semiconductors worth up to around $1000 will become necessary.

As a manufacturer of innovative and powerful semiconductor solutions that create new possibilities for specific developments in various areas, Analog Devices (ADI) is profiting from this continuously rising semiconductor share in vehicles. As a result, the company's revenues in the automotive field reached nearly 1 billion dollars, or 16% of total revenues, in 2018. ADI recorded the greatest share of automotive revenues in the EMEA region.

Automated Driving

The primary goal of automated driving, one of the megatrends that is truly revolutionizing the automotive industry, is for the vehicle to recognize its surroundings so that accidents can be prevented, the flow of traffic optimized, and life made easier for drivers.

For an autonomous vehicle to be able to detect its environment in a reliable manner, various sensors such as radar, light detection and ranging (lidar), and camera-based technologies are needed, whereby each of these three possibilities have disadvantages in different weather and visibility conditions. For example, the problem with a camera system is reliably identifying objects in bright backlighting conditions.

In contrast, radar sensors operate completely independently of the lighting in these situations, but can prove to be problematic, for example, in fog. In vehicles such as the new Audi A8 with level 3 automated driving capabilities, all three technologies are needed to cover all conceivable situations.

ADI addresses the radar field in the context of its Drive360™ strategy for autonomous driving with highly integrated radar sensors on a chip manufactured in economical 28 nm RF CMOS technology. The sensors have three transmitter channels and four receiver channels, and offer higher RF performance for timely recognition of smaller objects at greater distances. This gives the system more time to execute vehicle interventions or warnings.

Radar systems for powerful long distance applications such as advanced driver assistance systems (for example, adaptive cruise control or ACC for short); medium distances such as emergency brake assistance, collision avoidance systems, lane change assistants, and blind spot monitoring; and short-range parking assistants can be developed on the basis of radar sensors.

ADI acquired additional know-how for the realization of systems with radar sensors, including software and algorithms, for the automotive market through the acquisition of Munich-based Symeo in Spring 2018.

To be able to offer innovation solutions in the field of lidar and strengthen its position in the field of automotive safety systems in the future, ADI acquired the laser technology two years ago with the acquisition of Vescent Photonics. With this addition, ADI will make lidar technology more compact and robust, but primarily less expensive.

Data Security

As vehicle complexity increases, so does the danger of external attacks. Attackers could access data, pass it on, process it, destroy it, or manipulate it, thus the topic of data security plays a key role at ADI.

Nearly two years ago, ADI acquired the specialized Cyber Security Solutions division of Sypris Electronics so that it could optimally address this topic. The associated hardware and software technologies are also being implemented in products for the automotive field.

Monitoring Vital Signs

Another important safety aspect for avoiding accidents and saving lives when driving lies in the monitoring of vital signs. In close cooperation with B-Secur, ADI developed a solution in which sensors built into the steering wheel continuously record the driver's vital signs—for example, heart rate or blood oxygen saturation—and monitor his or her health status. Through this possibility, dizzy spells or impending heart attacks can be detected early enough for the vehicle to initiate appropriate measures via the advanced driver assistance system (ADAS). In case of serious problems, the ADAS could, for instance, reduce the speed of the vehicle or perform an automatic emergency braking operation. With the help of vital sign monitoring, the safety of the driver and the safety of all traffic participants can be substantially improved.

Analog Devices and B-Secur are also working on developing biometric authentication technologies for the automotive industry. The envisioned solutions unite ADI's signal processing technology and B-Secur's ECG software for biometric algorithms and enable clear authentication of drivers and passengers. Functions such as vehicle access or personalization of infotainment systems can be implemented with the help of the authentication technologies.

MEMS IMU Sensors

Analog Devices was the first company to develop accelerometers utilizing MEMS technology for high *g* MEMS sensors and establish this sensor type in numerous air bag systems. ADI is concentrating its current investments in this field on high precision rotary encoders and inertial sensors using MEMS technology. These sensors exhibit a very low drift and work in cooperation with the vehicle's positioning system. In autonomous vehicles, these sensors are needed in higher precision versions specifically to yield reliable position information.

Complete Power Management Solutions

For the second of the above-mentioned megatrends—electrification of the powertrain—the energy efficiency of the vehicle's system and the electrical energy savings that can be achieved play a dominant role. Optimal power management can significantly boost the energy savings. This increases the range of all-electric vehicles.

The topic of power management is therefore a high priority at ADI and is being addressed with solutions for the coupling of on-board energy networks, among other things. Examples from ADI's wide-ranging portfolio are the LT8708/LT8708-1 bidirectional buck–boost controller, which has an efficiency of 98% and is intended for use in redundant on-board 12 V/12 V networks in autonomous vehicles, and the LTC3871, with which developers are able to realize high efficiency and dynamic 48 V to 12 V converters in the kW range for use in plug-in hybrid vehicles.

Besides that, semiconductors of low quiescent current are necessary for achieving a long battery life. It is here that Analog Devices can score points and offer solutions for the development of automotive systems that must be continuously supplied, such as when the vehicle is stopped. The Silent Switcher® switching regulator family with a quiescent current of 2.5 µA as well as low noise, far surpasses the performance limit in the industry. Possible applications include keyless entry systems, security systems, and infotainment systems, as well as navigation and GPS localization.

Battery Management Systems (BMSes)

For electric vehicles to have a lasting, long range, and useful life, among other things, the charging and discharging limits of the battery must be precisely determined via a very exact cell voltage measurement. By acquiring Linear Technology, Analog Devices expanded its portfolio of BMS products, which have long been known for their superior measurement precision. This measurement precision is achieved through the use of a buried Zener diode as a reference voltage source, which offers a precision that can otherwise only be found in high quality laboratory instruments. The corresponding BMS products from a family with 6, 8, 12, 15, and 18 channels are available and are already being used in hybrid and all-electric vehicles.

Infotainment: Automotive Audio Bus (A^2B) and Car Camera Bus Technology (C^2B)

In the infotainment field, ADI has established itself as an automotive supplier that is pointing the way to the future. For example, in cooperation with a European automaker, the company began development of the Automotive Audio Bus™ (A^2B™) and showed that it is capable of recognizing customers' problems and supplying the corresponding solutions.

For example, the innovative and application-adapted A^2B technology allows for transmission of digital audio in hi-fi quality with reduced cabling requirements, and thus reduces the costs and weight of the cable harnesses by up to 75%, whereby the latter aspect in turn lowers the fuel consumption. A^2B is already being used by automakers such as Ford and will continue to become more widespread in the future due to its merits.

The automotive audio bus is designed for audio applications such as those with several in-vehicle microphones that, compared with analog connections, provide superior audio quality at a substantially lower system cost than that associated with current digital bus standards. Typical A^2B components are AD2426W, AD2427W, and AD2428W transceivers with configurable transmit power levels.

To transfer HD video via unshielded twisted-pair cables and connectors in the vehicle to the infotainment system at low cost, ADI developed the Car Camera Bus technology (C^2B™). The first C^2B components are the ADV7990 and ADV7991 transmitters as well as the ADV7380 and ADV7381 receivers, which create the conditions for OEMs to easily convert existing systems from SD to HD cameras and thus achieve the high resolution and image quality of today's in-vehicle camera applications.

In the development of the C²B components, ADI paid particular attention to techniques for reducing electromagnetic interference (EMI) and improving electromagnetic compatibility (EMC). The components are used in inexpensive vehicles in which, for example, the backup cameras are operated via analog, not digital, bus systems.

Generation of Engine Noise

In many regions, legislators require that slow-moving hybrid and electric vehicles produce an externally audible engine noise so that they can be registered in good time, for example, by pedestrians. For this purpose, ADI has a solution based on the ADSP-BF706 Blackfin® signal processor and electric vehicle warning sound system (EVWSS) firmware in its range to give automakers the ability to comply with future safety regulations.

Outlook

Looking to the future, ADI sees numerous possibilities and ways of achieving much more with sensors than before. One thing that comes to mind is the user interface (HMI) already being used by BMW and other manufacturers today to respond to gesture controls.

Other solutions—for example, driver monitoring system (DMS) solutions—could monitor vehicle interiors for security reasons. A current application is adaptation of the direction from which the airbag is triggered by a collision to the given sitting posture of the passenger to reduce the risk of injury. Driver monitoring systems have the potential to become standard in-vehicle applications today—and especially in the future.

Specifically with automated driving, it is important to recognize, with the help of the corresponding sensors, whether the driver is even capable of taking back control of the vehicle after previously relinquishing it.

In the future, monitoring the vital signs of drivers and passengers will play an important role as level 3 or level 4 vehicles must be able to automatically return to a safe condition if the driver cannot take back control for health reasons.

Trends in Brief

A multiplicity of sensors with associated signal processing, high efficiency power management solutions, and well-thought-out bus systems is one of the key components of modern vehicles. Regardless of whether further enhancements to the user interface or powerful driver monitoring based on vital parameters is desired in future vehicle generations, Analog Devices is meeting the challenge and already working on innovative and suitable solutions.

About the Author

Stefan Steyerl is serving as sales director for the Mobility and Transportation Group across Analog Devices EMEA, as head of marketing EMEA, and as managing director for Analog Devices GmbH in Germany.

Stefan brings a wealth of both company and industry experience to his roles, having worked at Analog Devices for over 25 years. Under his leadership in the late 1990s, the digital signal processing (DSP) business was built up and expanded in EMEA. In 2008, Stefan assumed the position of sales director of automotive EMEA, whilst also taking on responsibility for automotive customers in North and South America from 2009 to 2015. Under his direction, the automotive business was a key contributor to ADI's strong growth.

For the past years, Stefan has also been responsible for preparing and transitioning the Central European sales organization into the next phase of growth, supporting the company's ambitions in the expanded market. In 2017, he has been heading up the development of the new EMEA sales vision, strategy, and organizational structure including the integration of Linear Technology, Inc.

Stefan Steyerl graduated with a Dipl.-Ing. degree in electronic engineering from the Technical University in Munich, Germany. He can be reached at *stefan.steyerl@analog.com*.

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