

ADAS and autonomous driving hits the fast lane for smarter, safer vehicles

Eaton provides an overview of the trends and dynamics of advanced driver assistance systems (ADAS) and automated driving systems (ADS) as it pertains to power and communication technologies, including details of design and reliability challenges associated with these technologies. Furthermore, this article discusses solutions to these challenges using industry-leading, new technologies catered to solving these challenges.

Integrating intuitive driving systems

The latest ADASs perform highly valued safety features, such as Adaptive Cruise Control (ACC), Vision Systems, Traction Stability Systems, and Emergency Call Unit features. These systems and others now enable the development and testing of autonomous vehicles, which promise to enhance road safety and driver convenience.

However, these benefits also come at the cost of introducing a large number of additional sensors, processors, actuators, and communication lines, both wired and wireless, which require stable and protected power and communication interfaces. Most vehicles will require new designs to account for the increased power needs, reliability, and interference protection of these new systems. New communication and power technologies are necessary to optimize the performance of ADAS and ADS.

ADAS and ADS Trends

The increase in congestion on the roadways are leading to an increase in amount of road accidents and fatalities, thus creating a demand for ADAS technologies. According to market research, the global ADAS market is likely to grow by over 10% for the next several years and more than double by 2023 [1]. As automobile consumers and truck fleet operators begin to gain interest in ADAS technologies, there are also government initiatives starting to provide regulation enforcing safer automobile operation.

Moreover, there are an increasing number of large private companies and venture-capital backed startups, often with the aim of developing autonomous driving systems, working to develop new and improved ADAS technologies. This is projected to lead to greater diversity and capability of ADAS devices, components, and software tools.

The general trends for ADAS/ADS are the inclusion, integration, and fusion of a variety of sensors and actuators which provide features that are either electrical upgrades of legacy mechanical systems or offer entirely new features. These sensors and actuators require power, communication, and processing effort. Additional electronics are required to supply reliable power, robust communications, and low-latency/high-bandwidth processing.

Processors, mainly electronic control units (ECUs) or microprocessors (MPUs), are being developed with greater processing bandwidth, higher clock rates, and more integrated automotive features to better serve the demands. These include automated systems, machine learning/artificial intelligence (ML/AI), and facilitating connected car communications (i.e., telematics). Processors are also needed to acquire, store, and analyze the data provided from a wide range of new ADAS sensors, such as vision systems (IR/visual cameras), ultrasonic range sensors, radar, and Lidar.

These sensors and processors additionally all need to communicate via data lines, or in some cases, wireless. Traditional automotive communication technologies, such as CAN-BUS and CAN-FD, may not be capable of handling the bandwidth and low-latency requirements of newer ADAS sensors. Commercial data communications technologies, such as Ethernet, are beginning to gain popularity to avoid bandwidth bottlenecks. Wireless communications, either among a car's systems, vehicles within a set vicinity (vehicle-to-vehicle), or with automotive infrastructure, is also likely to emerge and will bring its own set of power, processing, and interference considerations.



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Electric actuator systems, such as electronic door locks and safety belt tensioners, are poised to replace legacy mechanical systems. This trend is also true for steering, brakes, and other driving systems. With electrical control also comes the ability to provide assist systems for braking, steering, traction control, and other systems which may eventually enable fully autonomous operation.

Considerations for modern ADAS and ADS

All of the additional electronics, power lines, and data cables required for modern ADAS all present unique considerations beyond what vehicle manufacturers and automotive OEMs have previously taken into account. The following sections discuss solutions which can be employed and enable cutting-edge ADAS.

ADAS and ADS Electronics meeting stringent automotive requirements

Many of the sensors, actuators, electronics, and interconnect now used with ADAS were not initially designed for automotive applications. Hence, the materials and design of these components may be sub-standard to the stringent automotive reliability requirements. These requirements involve rigorous qualification and testing for aging, electrostatic discharge (ESD), shock/vibration, and high voltage spikes. For example, a typical load dump test has a sudden change in load that may cause voltage spikes as high as 60 V for standard 12 V and 24 V car systems.

The latest electronic vehicles have much higher battery voltages, not to mention the reduced internal resistance of lithium-ion batteries compared to lead-acid, load dump voltage spikes, and other transients far exceeding that of prior automobiles. Therefore, automobile manufacturers must carefully select processors, actuators, sensors, and communication components and devices that meet and even exceed current standards. This ensures reliable ADAS operation and avoids costly recalls and accidents due to system failure.

Reducing component size and accounting for non-12 V power conversion

Another challenge of incorporating additional electronics in an already confined platform is that every additional module requires ruggedized housing, placement, and cabling, adding weight and requiring space. The size of a given ADAS module is largely constrained, meaning that to achieve the desired performance specification or feature set, designers will need to find a way to enhance integration, reduce component count, or find more compact components.

Developing technologies allowing for greater integration often takes several years and come with a variety of performance tradeoffs. Similarly, reducing component count is the opposite of what trends are any indication. Therefore, the only available option for designers to reduce ADAS module size is to use more compact components.

For example, many ADAS require voltages lower than 12 V and power converters are a necessity. Power converter designs often require inductors, which tend to be bulky. However, leveraging high-frequency and high current inductors for high switching speed DC/DC converters enables a significant reduction in inductor footprint and weight. Given that most sensors, processors, and communications devices will need power converters to reduce 12 V automobile voltage to a usable range, even a slight reduction in inductor size and weight would have compounding benefits.

New data, communication, and sensor technologies bring ESD and power surge challenges

As each new ADAS sensor requires power and communication lines, this leads to a proliferation of interconnect within the automobile. With modern electronics installed throughout an automobile, long and complex cable routing of the latest data-rate cables, such as twisted-pair ethernet, HDMI, and USB, increases the electrical length of the

cables. It also increases the risk and severity of ESD to sensitive sensors, processors, and communications electronics. Typically, the shielding, if any, for high-speed cables isn't designed to handle the harsh automobile environment, and may not be adequate for the length of cabling and ESD in a mobile environment.

During electronics and cabling installation in a factory, operators may not be familiar or required to perform ESD-safe installation, which could subject sensitive ADAS electronics to static shock. Moreover, the blade fuses used in automobiles are generally rated for several amps at 12 V, equating to power ranges between 24 W and 12 W for 2 amp to 10 amp fuses. Many ADAS electronics could be damaged by current surges of a few amps and aren't sufficiently protected by standard blade fuses.

Additionally, a surge event could be caused by as mundane an activity as starting an internal-combustion engine car, or an electric vehicle switching from its low-voltage battery to the main battery pack. Hence, to protect ADAS electronics, each module will benefit from both high inrush withstand fuses to protect against short circuits as well as ESD suppressors on communication lines for protection against ESD events. Size, weight, and cost are critical for these components. Small form factor ESD and circuit protection, such as SMT chip fuses and ESD suppressors, are an ideal way of handling these issues without investing in a system redesign or requiring additional services from installation or maintenance operators.

Distributed emergency power systems fail-safe operation

There are several new systems employed by modern cars to enhance safety outside of the driving experience. These systems include autonomous door locks (e-latch), emergency location and calling, airbag sensors, and emergency lighting elements. In the case of engine failure, or battery power loss in the case of electric vehicles disengaging the main battery during accidents, many of these recently electrified systems would fail unless back-up power is provided. During accidents, a single power source is a significant liability to the operation of emergency safety devices. Distributed emergency power systems help to reduce or eliminate such a liability.

There are a variety of technologies that could be used for automobile emergency power. However, supercapacitors tend to offer a superior combination of weight, cost, reliability, and performance compared to current alternatives. As there are already automotive OEM qualified supercapacitor cells available, several supercapacitors distributed throughout an automobile can provide adequate stored energy to operate the passive safety equipment, such as airbags, seat belts, body controls, emergency lighting, and more.

Prioritizing electronic components in modern vehicle design

The increased complexity of automobile ADAS is designed to combat dangerous driving conditions brought on by the growing numbers of automobiles on the road and aging populations. ADAS are also likely to open the door to autonomous driving technologies that both enhance driver safety and reduce the burden of driving. However, the complexity and requirements of ADAS demand additional considerations from automobile manufacturers to ensure that the ADAS sensors, actuators, processors, and communications electronics are adequately powered and protected by other electronic components with qualified reliability to operate in the harshest automotive environment.

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