VEHICLE electronics

The monthly magazine for automotive electronics engineers

OnSemi and AImotive partner on sensor fusion

On Semiconductor and AImotive are working together to develop prototype sensor fusion platforms for automotive.

The collaboration should help users explore integrated options for future sensor data conditioning hardware.

The companies plan to develop hardware demonstrators combining OnSemi's HD camera and radar sensor and preprocessor chipsets with AImotive's AI-based perception algorithms, hardware acceleration and simulation capabilities.

"Our customers have been asking us to help them deliver better performance by combining different sensors," said Davide Santo, senior director at OnSemi. "When undertaking such challenges, AI and simulation are key technologies to help build future-proof products and development processes."

The platforms aim to show the accuracy, robustness and low latency of AI-based real-time sensor fusion and will use AImotive's AiWare hardware neural network acceleration IP in FPGA-based prototypes, as well as modules from its AiDrive software portfolio and its AiSim simulation environment.

"Together we can demonstrate that, with the right chips and algorithms, more highly integrated sensor fusion can achieve superior performance, while also being cost-effective and practical for volume production," said Laszlo Kishonti, CEO of Hungary-based AImotive.

OnSemi offers all four sensor modalities – imaging, radar, lidar and ultrasonic. These can address future vehicle requirements for sensor fusion platforms that support adas and autonomous driving.

Future autonomous driving platforms will require the fusion of data from multiple different sensor types to achieve the necessary robustness and the quality in all operating conditions.



AImotive partners OnSemi on sensor fusion

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Samsung and Synopsys combine on functional safety

Synopsys and Samsung are working together to deliver automotive chips that meet Asils for adas.

The collaboration sees Samsung's automotive reference flow enabled to meet target Asils for safety-critical designs. Based on its 8LPP process, Samsung's automotive reference flow has been tuned to various process technologies.

"In close collaboration with Synopsys, we have created a world-class automotive reference flow based on our technology," said Jung Yun Choi, VP at Samsung Electronics.

Synopsys' automotive designs deliver complex functional safety analysis, implementation and verification. Differentiated offerings for automotive design, such as unified functional safety verification, help designers prove during planning and implementation that their chip safety architecture can achieve target Asils.

Designers can perform failure mode and effects analysis and failure mode effects and diagnostic analysis through Synopsys' VC functional safety manager that combines technologies for fault campaign management.

Early functional safety analysis at RTL or gate level can identify candidates for triple-mode redundancy and dual-core lock-step redundancy and estimate ISO 26262 metrics for target Asils.

Digital and analogue fault injection and simulation can produce reliable metrics. Synopsys also provides products to address reliability in automotive design, including electro-migration, voltage drop, device aging and redundant via insertion capabilities.

Synopsys provides designers with a portfolio of automotive IP that is designed and tested for AEC-Q100 reliability, offers Asil-ready ISO 26262 certification, and supports automotive quality management.

Theo bats for motorists in claims



Meet Theo. This little video-enabled device is said to beat dashcams hands down because of its combination of adas and other technologies.

Created by Mike Brockman, a pioneer in road safety technology, Theo works in the interests of the driver, responding to demand from motorists for fairer treatment from insurers.

Unlike a dashcam, every Theo has an HD video camera, two-way Amazon Lex integrated speaker, telematics for tracking, impact detector for crashes and its own internal 4G sim card for connectivity, which connected to the cloud gives drivers access to an array of services. Theo will also warn drivers if they get too close to the car in front.

In a collision, video footage and telematics data are sent in real time to an accident assistance centre. Theo will speak to the driver to check if they are OK and alert emergency services if necessary. Following the initial support, the Theo team will then work to achieve the best outcome in respect of an insurance claim, using the Theo data combined with their own expertise.

"Dashcams have become hugely popular, but they are still relatively rudimentary and do little to make driving safer or to really help motorists in an insurance claim," said Brockman.

Xilinx increases control

Steve Rogerson reports from last month's Xilinx XDF event

Xilinx is no stranger to the automotive world. In fact, it has shipped 167m devices into this field with 67m of them being for adas applications. However, most of that has been in edge applications where artificial intelligence (AI) is being used in sensor systems for the likes of object detection and collision avoidance.

But to achieve the autonomous and connected vehicles of tomorrow, sensor fusion will be key and thus at the firm's XDF event in The Hague last month it moved up the chain with its XAZU7 and XAZU11 domain controllers, launched with the bold claim that these parts deliver the highest programmable capacity, performance and IO capabilities for levels two to four automated driving applications.

"What we are talking about are the domain controllers that sit at the centre of the system," said Wayne Lyons, Xilinx director for automotive marketing. "These are bringing in information from all over the vehicle. All the data from radar, lidar and so on need to be synchronised."

The Zynq UltraScale+ MPSoC devices have more than 650,000 programmable logic cells and nearly 3000 DSP slices. In addition, the XAZU7 contains a video codec unit for h.264/h.265 encode and decode, while the XAZU11 includes 32 12.5Gbit/s transceivers and provides four PCIe Gen3x16 blocks.

The addition of these devices to the XA portfolio can help car makers, robo-taxi developers and tier-one suppliers perform the data aggregation, pre-processing and distribution (DAPD) and compute acceleration in a power envelope that allows for scalable production deployments for autonomous vehicles.



Wayne Lyons: "AI is at the heart of adas."

"We now have a continuum from edge sensors all the way to domain controllers," said Lyons. "We have certified these devices specifically for automotive."

This sees Xilinx bring more AI to automotive.

"AI is at the heart of adas," said Lyons, "with in-cabin experiences such as driver monitoring, and it is at the forefront of autonomous driving."

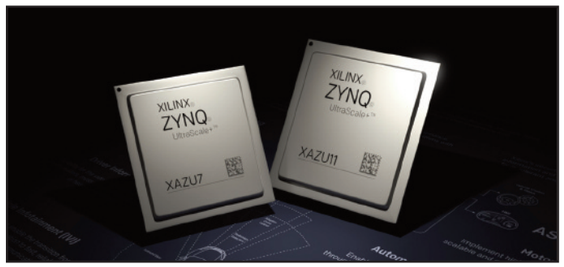
He said CPUs and GPUs were perfectly good at optimising AI and had been doing so for years, but there was a trade-off between high throughput and low latency. It was hard to get both.

"With AI in Xilinx, we can have the inputs and outputs going through at the same time, so you get a much faster response," he said.

These controllers are part of Xilinx's realisation that silicon platforms have to be adaptive given how difficult it is to develop for smaller geometries.

"Adaptive computing lets you apply running changes to your silicon when it is out there," said Lyons.

Examples of how these can be used were announced through partnerships with Wind River to combine hardware and software to produce a platform for automated driving and with Belgian company Silex for a hardware security module embedded in an FPGA for safeguarding and managing digital keys.



Xilinx XAZU7 and XAZU11 domain controllers

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Hyundai AI learns styles of driving

Hyundai has developed machine-learning based smart cruise control (SCC-ML) technology that incorporates the driver's patterns into its self-driving behaviour, creating a custom experience for the driver.

"The new SCC-ML improves upon the intelligence of the previous adas technology to dramatically improve the practicality of semi-autonomous features," said Woongjun Jang, vice president at Hyundai Motor. "Hyundai will continue the development efforts on innovative AI technologies to lead the industry in the field of autonomous driving."

Smart cruise control enables an essential self-driving feature and core technology for adas, maintaining distance from the vehicle ahead while traveling at the speed selected by the driver.

SCC-ML combines AI and SCC into a system that learns the driver's patterns and habits on its own. Through machine learning, it autonomously drives in an identical pattern as that of the driver.

To operate the previous SCC, the driver manually adjusted driving patterns, such as the distance from the preceding vehicle and acceleration. It was impossible to fine-tune meticulously the settings to accommodate the diver's individual preferences without machine-learning technology.

For instance, even the same driver may accelerate differently in high-, mid- and low-speed environments depending on the circumstance, but detailed fine-tuning was not available. Therefore, when SCC was activated and the vehicle operated differently to their preference, drivers sensed the difference and this resulted in a reluctance to use the technology.

With SCC-ML, first sensors such as the front camera and radar constantly acquire driving information and send it to the central computer. The computer extracts relevant details from the information to identify the driver's patterns. A machine-learning algorithm is applied during this process.



AI learns driving style preferences

The driving pattern can be categorised into distance from preceding vehicles, acceleration and responsiveness. Driving conditions and speeds are also considered, such as maintaining a short distance from the preceding vehicle during slow city driving and further away when in the overtaking lane.

Taking these conditions into account, SCC-ML makes an analysis to distinguish over 10,000 patterns, and this flexible technology can adapt to any driver's patterns.

The pattern information is regularly updated with sensors, reflecting the driver's latest driving style. It is also programmed to avoid learning unsafe driving patterns.

VW strengthens software development

Volkswagen plan to invest over €7bn in its Car Software organisation by 2025 and make it an independent business unit within the group responsible for in-car software.

This will centralise the associates and subsidiaries within the group that develop car software and software for the digital ecosystems.

Initially, around 3000 digital experts from the software-related associates and subsidiaries will be grouped together in this unit. The plan is to increase this to 10,000 by 2025 through new hires, strategic acquisitions and partnerships.

The organisation will be based at Audi Electronics Venture, and incorporate German sites in Berlin, Bochum, Ingolstadt, Stuttgart and Wolfsburg. Other locations include Seattle and Beijing.

"With our Car Software organisation we will create an ideal platform for pioneering software development in the Volkswagen group," said Christian Senger, from the VW board. "We are stepping up our efforts."

VW aims to boost the in-house share of car software development from less than ten per cent to at least 60 per cent by 2025.

Fleet management use to grow 14% in Europe

The installed base of fleet management systems in Europe will reach 17.6 million by 2023, according to market watcher Berg Insight.

The number of active fleet management systems in commercial vehicle fleets in Europe was 9.1 million in Q4 2018. Growing at a CAGR of 14.1 per cent, this number is expected to reach 17.6 million by 2023.

The top 22 vendors have today more than 100,000 active units in Europe. Webfleet's subscriber base has grown both organically and by acquisitions during the past years and the company is the clear market leader on the European market and reached an installed base of about 770,000 units by the end of 2018.

Verizon Connect is in second place and had achieved an installed base of 300,000 units. Abax and Masternaut follow and have reached more than 220,000 units each.

Targa Telematics, Microlise, Gurtam, Viasat and Bornemann are also among the ten largest providers with 174,000 to 192,000 units each.

Some notable players just outside of the top ten list are Teletrac Navman, Fleet Complete, Transics, Trimble, Ocean (Orange), Macnil, GS Group, Quartix, Eurowag Telematics, Ctrack (Inseego), Optimum Automotive, Ram Tracking, Cartrack, Radius Payment and Connexas Group.

The HCV manufacturers are now growing their subscriber bases considerably in Europe thanks to standard line fitment of fleet management products. FleetBoard by Daimler, Dynafleet by Volvo and Scania Fleet Management are the most successful with active subscriber bases of 117,000, 128,000 and 255,000 units respectively as of Q4 2018.

The consolidation trend on this market continued in 2019.

"Twelve major mergers and acquisitions have taken place in the past twelve months among the vendors of fleet management systems in Europe," said Johan Fagerberg, analyst at Berg Insight.



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Utac hits ISO 26262

Semiconductor test and assembly services provider Utac has been awarded ISO 26262 for its automotive manufacturing facility in Bangkok.

Utac says it will create, foster and sustain a safety culture that supports and encourages the effective achievement of functional safety, which will include the creation of specific rules and processes.

The company is already qualified to ISO9001 and IATF16949.

"We are delighted to receive this accreditation," said Darren Smith, senior vice president of Utac. "It is the result of significant work by our talented employees and further demonstrates the importance of the automotive market to our business, and our commitment to achieve the highest levels of quality.

"Automotive customers can now be further assured that even the most safety-critical automotive systems developed or manufactured by Utac will meet the very highest levels of safety, both now and in the future."

Singapore-based Utac is an independent provider of assembly and test services for a broad range of semiconductor chips.



NXP, Venucia and Hangsheng produce smart e-cockpit

A collaboration between Chinese car maker Venucia, local firm Hangsheng Electronics and Dutch chip maker NXP has led to the mass production of a smart e-cockpit.

Developed at the Dongfeng-Nissan Technology Center in China, the Venucia 3.0 Plus uses NXP's i.MX 8QuadMax applications processor to bring a dynamic dashboard with digital clusters for multimedia, extended functionality including vehicle-to-home connectivity, anytime online navigation and sensor-based climate control.

NXP's hardware partitioning architecture and capability to run multiple operating systems, without a hypervisor, ensures that the subsystems – including safety-critical displays – remain functioning.

"Advanced, reliable and scalable systems are the primary considerations for Hangsheng," said Yang Hong, president of Shenzhen-based Hangsheng Electronics. "NXP's i.MX 8 QuadMax has attracted a lot of attention in the industry since it was announced, providing a powerful processing platform for in-vehicle infotainment systems. NXP's strong expertise and global partner ecosystem certainly backed the successful development and product launch."

As one of the first smart cars with an e-cockpit powered by the i.MX 8QuadMax applications processor, the Venucia T90 is said to represent a leap in performance.

"When it comes to user experience, the next-generation Venucia 3.0 Plus can provide real-time multimedia entertainment, taking the performance of in-vehicle devices to a new level," said Ma Lei, general manager of Venucia. "We are very excited to have NXP's latest technology on the all-new Venucia T90. The development of connected vehicles in the future will require technology that keeps pushing the boundaries. We hope to deepen our collaboration in the field of smart vehicles, to provide a more powerful and more intelligent automotive brain for consumers."

The i.MX 8QuadMax integrates two Arm Cortex A72 cores, four Cortex-A53 cores, two Cortex-M4F cores, two GC7000XS/VX GPUs and HiFi 4 DSP, LPDDR4 memory support as well as dual Gigabit Ethernet with audio video bridging capability.

Ron Martino, a vice president at NXP, added: "The future of transportation relies on auto and tech industry leaders working together to develop a scalable platform that automakers around the globe can adopt, customise and deploy."

Cree and STM extend SiC wafer deal

Cree and ST Microelectronics have expanded and extended their multi-year, long-term silicon carbide (SiC) wafer supply agreement to more than $500m.

The extended agreement is a doubling in value of the original agreement for the supply of Cree's 150mm SiC bare and epitaxial wafers to STM over the next several years.

The increased wafer supply enables the companies to address the growing demand for SiC power devices globally, particularly in automotive and industrial.

"Expanding our long-term wafer supply agreement with Cree will increase the flexibility of our global SiC substrate supply," said Jean-Marc Chery, CEO of STM. "It will further contribute to securing the required volume of substrate we need to manufacture our SiC-based products as we ramp up production over the next years for the increasing number of programmes won at automotive and industrial customers."

The adoption of SiC is rapidly growing across the automotive market as the industry seeks to accelerate its move from internal combustion engines to electric vehicles, enabling greater system efficiencies that result in electric cars with longer range and faster charging, while reducing cost, lowering weight and conserving space.

"SiC delivers performance enhancements that are critical to electric vehicles," said Gregg Lowe, CEO of Cree.

Autonomous car ride in Jerusalem



Gretchen Whitmer, the governor of Michigan in the USA, is seen with Mobileye CEO Amnon Shashua as they prepare for an autonomous car ride through the busy streets of Jerusalem. During the visit, Whitmer announced a pilot programme using Mobileye's collision avoidance technology for the Michigan government's fleet vehicles.

She said the pilot would enhance the safety of existing state and city fleets through the application of Mobileye 8 Connect aftermarket systems for collision avoidance. The trial is part of Michigan's objective to enhance road safety today while paving the way for autonomous vehicles.

The meeting explored ways that Intel subsidiary Mobileye's technology could be used to improve road safety, reduce collision-related costs, gain insight into local collision hotspots, and prepare the state for broad deployment of robo-taxis and autonomous vehicles.

"This programme will demonstrate the potential of driving assistance technology to save lives, reduce collision-related costs and help diminish traffic congestion," she said.

JLR printed electronics personalise vehicles

Jaguar Land Rover's structural electronics research could allow dashboards to be replaced by curved screens and let drivers customise interiors thanks to colour-changing body panels.

The car maker is developing Lesa – for lightweight electronics in simplified architecture – research technology used in flexible wearables and curved OLED TVs for car interiors.

This has the potential to offer drivers greater ability to customise their cars to suit their needs.

With Lesa technology, JLR will be able to make body panel displays to show information only when needed to help designers achieve streamlined and button-less designs. Such designs may include, customisable interior ambient lighting, body controls, wraparound button-less dashboards and fabric or leather heated steering wheels.

The printed electronics system will also reduce the weight of in-car electronics by up to 60% as wiring, sensors and computing is contained within all non-metal materials, removing the need for extra packaging space for control units.

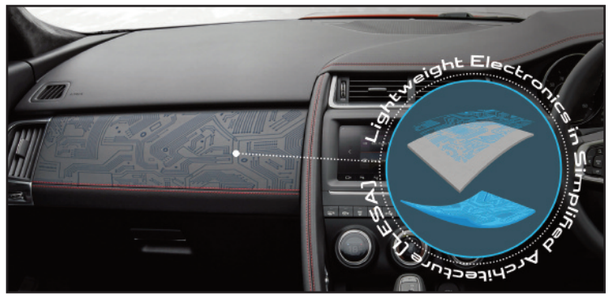
Features could be created using a faster, simpler and more automated process, be more flexible in usage and offer technological advancements such as making digital displays appear on surfaces such as wood without the need for a screen.

It also makes adding solar panels to the vehicle possible without increasing weight. The renewable power generated from the sun could then recharge the battery.

The system uses computer-animated drawings (CADs) to unfold virtually a part into its 2D structure. The required electronic circuit, ordinarily wired into a traditional ECU, is then printed onto the flat surface, and components are mounted, before the CAD is folded back into its original 3D. The part is then manufactured with the electronics printed into the structure.

JLR has trialled Lesa on an overhead control panel prototype, achieving a weight reduction of 60% and reducing the part size from 50 to 3.5mm.

"Healthcare, aerospace, consumer technology and military industries are already harnessing the benefits of structural electronics and our research is leading the way in the automotive sector by bringing it into the cabin for the first time," said Ashutosh Tomar, Jaguar Land Rover electrical research technical manager. "We believe Lesa represents the future of vehicle electronics and will enable us to design and manufacture innovative, flexible and customisable cabins for our customers while also reducing weight and cost during production."



Printed electronics can replace dashboards with curved screens

Pailton brings memory to bus steering wheels

Steering system specialist Pailton Engineering has developed an electric memory steering column for buses and coaches.

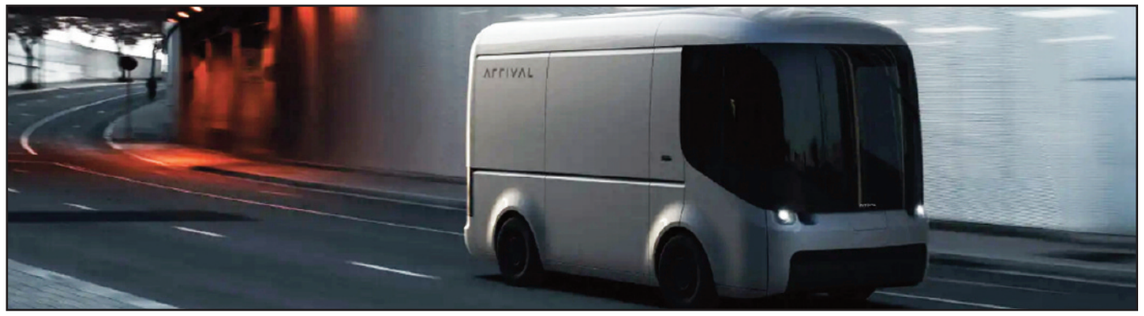
The product lets the steering wheel position automatically adjust for drivers on an individual basis, controlled by a joystick or Bluetooth connection.

First seen at Busworld in Brussels in October, the product has now been brought to market in collaboration with Continental, seat provider Isri and electric bus manufacturer Ebusco.

The product's memory records the optimal position for each driver, removing the need to adjust the steering manually when a driver starts a new shift.

With this design, Pailton Engineering aims to reduce the bus driver injuries and chronic conditions associated with sub-optimal driver conditions.

"We've already had a great response from the bus industry," said Roger Brereton, who is head of sales at Pailton Engineering. "This new product is one that is very much needed in order to keep bus drivers healthy, to ensure the driving occupation remains attractive and to keep work-related chronic conditions to a minimum."



Arrival autonomous commercial vehicle

Blackberry QNX arrives at Arrival and…

Electric vehicle company Arrival's intelligent, autonomous-ready commercial vehicles will be powered by Blackberry QNX technology.

Blackberry will license the technology to Arrival, including its QNX SDP 7.0 rtos to serve as the safe and secure foundation for adas within the autonomous-ready commercial vehicles.

Prototypes of the first full version of the electric delivery vans are set to hit the roads in early 2020. DHL, Royal Mail and John Lewis will trial the lightweight EVs.

"Arrival's EVs represent a step change in the automotive industry, combining the very best technology to create a fully connected device on wheels that is a complete pleasure to drive," said Sergey Malygin, chief of technology at Arrival. We are thrilled to be working with Blackberry whose impressive track record and commitment to safety and security make them a perfect partner."

QNX SDP 7.0 provides kernel-level security with features such as microkernel architecture, file encryption, adaptive time partitioning, high availability framework, anomaly detection and multi-level policy-based access control.

Featuring the QNX Neutrino rtos and QNX Momentics tool suite, this platform helps guard against malfunctions, malware and cyber attacks by implementing a multi-level, policy-driven security model that incorporates security technology from Blackberry. The OS is certified to ISO 26262 Asil D.

"Arrival is committed to helping drivers to make a seamless switch to EVs and the opportunity to contribute our technology to their second generation of intelligent electric commercial vehicles is a real privilege," said John Wall, senior vice-president at Blackberry.

…Etas and Blackberry cooperate on Autosar Adaptive

Etas and Blackberry QNX are working together to develop a software platform based on Autosar Adaptive.

They plan to market jointly the safety-critical platform for use in connected and autonomous vehicles.

Both will combine their assets to develop and sell a software platform and associated tools for vehicle computers and domain controllers based on the Autosar Adaptive standard. This will unite Blackberry QNX's Posix-compliant, safety-certified real time operating system and hypervisor as well as Etas' expertise in functional safety and basic software based on the Autosar Adaptive standard.

It should provide a safe and secure foundation for developing microprocessor-based vehicle computer and domain controller electronic control units.

The combination will comply with ISO 26262: 2018 allowing use in systems up to and including Asil D.

"With this cooperation we are striving to create the leading microprocessor-based automotive software platform supporting the Autosar Adaptive standard," said Friedhelm Pickhard, chairman of Bosch subsidiary Etas.

John Wall, senior vice president of Blackberry QNX, added: "Collaborating with Etas will grow our leadership in software-defined vehicles, and serve as a catalyst for the automotive industry to build highly-secure connected and autonomous vehicles."

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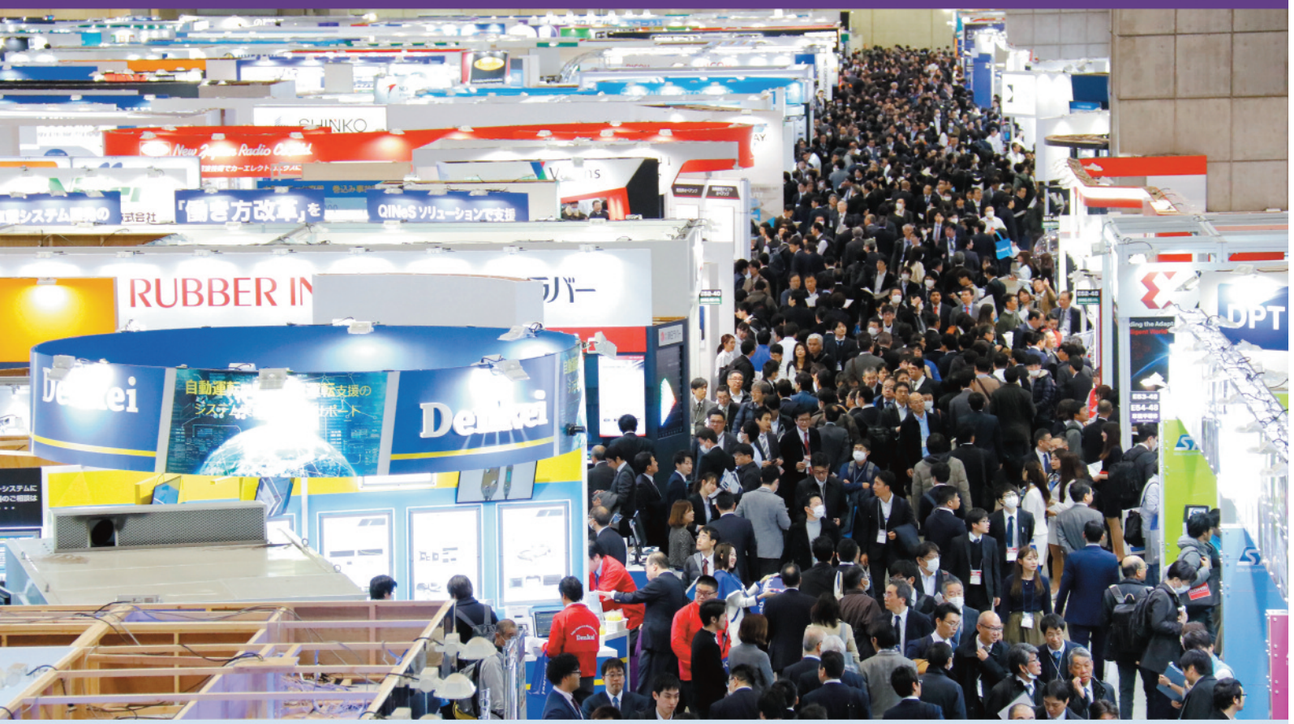
*"Largest" in reference to the exhibitor number and the net exhibit space of trade shows with the same concept.

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TÜV SÜD backs Wind River Asil D Autosar certification

Certification authority TÜV SÜD has endorsed an ISO 26262 Asil D certification programme for Wind River's Autosar Adaptive software platform.

The software provides a foundation for adas and autonomous driving systems. The safety certification process is underway.



The software provides a foundation for adas

"TÜV SÜD Rail assessed the preliminary software safety concept for the software, as well as the Wind River plans and standards to be used, and has determined them to be suitable to fulfil the requirements in accordance to Asil D ISO 26262: 2018," said Günter Greil, business line manager at TÜV SÜD Rail.

The certification-ready software platform is architected to support the high levels of safety and leverage the power of the underlying operating environments, such as the VxWorks RTOS or Wind River Linux, to provide a flexible and extensible services-oriented architecture for connected and autonomous vehicle applications.

This Autosar Adaptive platform offers portability of applications and algorithms across any target environment, allowing compute to be placed where it is most productive for the performance of the overall system. The platform will also deliver a path to the component and system-level safety necessary to deliver confidence at higher levels of vehicle autonomy.

"To achieve higher levels of autonomy, we must have a clear view for delivering on functional safety, both at a component and at a system level," said Matt Jones, vice president at Wind River. "Wind River has built its business on how to support customers in safety-critical industries, and managing the complexities associated with certification processes is a core competency of our team."

He said this was not isolated to automotive.

"We are drawing from decades of experience in safety-critical industries and applying our proven expertise to this certification programme," he said. "Our work to certify this software platform is a continuation of our legacy of providing comprehensive safety and certification expertise."

Once the certification process is complete, it will add to the firm's existing list of safety certifications, which includes those for VxWorks Cert Edition and its commercial off-the-shelf evidence.

AI checks for mobile phones and smoking

AI computer vision firm Eyesight Technologies has added features to its DriverSense and FleetSense products to detect driver distraction as a result of mobile phone use and smoking.

The features will be added to the company's existing distraction and drowsiness detection capabilities.

The single greatest distraction to drivers, the use of mobile phones, accounts for a quarter of all accidents and 14% of all fatal accidents on the road.

According to an AT&T survey, 43% of teens and 49% of adults admit to texting while driving. The same dangers hold true for cigarette smokers, as an independent study by the National Highway Traffic Safety Administration concluded, accidents were two to three times more likely as a result of smoking while driving.

The DriverSense driver monitor analyses the driver's facial features, including head pose, gaze vector, blink rate and eye openness to detect signs of drowsiness and distraction. The latest update increases the scope of the monitoring to beyond physical attributes of the driver to recognise driver actions, and can now detect the smoking of a cigarette and mobile phone related distractions.

The capabilities let car makers intelligently alert the driver based on the type of distraction.



PLAYING THE ACES

Steve Rogerson reports from last month's Mentor IESF Automotive conference in Munich

The levels of complexity in designing a vehicle today would have been impossible just a few years ago. This is not just from an electronics point of view but from the perspective of the whole vehicle from mechanical to software.

The design of vehicles is at the start of what is being called a new megatrend. It goes under the acronym ACES, for autonomous (or possibly adas), connected, electrical and sharing, and it basically means everything is connected and simulated.

So, to achieve modern connected vehicles, engineers now have to work across all the domains within the vehicle and model accurately what is going on outside the vehicle. This theme ran through all threads at last month's IESF Automotive conference in Munich, organised by Siemens subsidiary Mentor.

"It is now mandatory to work across different domains," said Andrew Macleod, automotive marketing director for Siemens, as he opened the event. "This goes from chip to city, from IC design to smart city development."

This involves taking software deign tools and combining them in ways that make sense.

"We use digital twins to make it easier to combine with other technologies," said Macleod. "We want an open ecosystem where you can pull in things not just from Siemens but from other areas as well."

The idea of digital twins – not just of vehicles but of the components that make up vehicles and the world in which they will be driving – is to show how a vehicle will behave without expensive prototypes and proving ground testing.

"We can now simulate the vehicle, the occupants and right down to the physical condition of the tyres," he said. "We can take it up to the city level to see how it will behave in complex environments. We can add ice, rain, whatever. We can combine all these to solve problems in new and unique ways."

This is no easy task. The amount of data in modern vehicles will be enormous. There could be 4Tbyte of data every hour going round the vehicle. Autonomous driving could add around thirty sensors to a vehicle. So how do you make all this work together?

"The engineering process is still largely the same," said Martin O'Brien, a senior vice president at Siemens. "You still have the V model. But you have to simulate thousands of driving scenarios. This means every system in the vehicle has to be described in a functional model. Model-based systems engineering is here to stay."

ACES, he said, was both an existential threat and a big opportunity. Digital twins, he said, were necessary and brought real value.

"It is obvious to anybody in the electrical domain that to understand what goes on in the car does not stop at the electrical wiring level," he said. "You need to co-design. Mechanical co-design is essential. The type of modelling that has been done at the PCB level has to be done at the whole vehicle level. You have to know instantly across all the metrics what the effects will be of every small change."

Chet Babla, vice president for automotive at Arm, reminded people of the scale of the problem by pointing out that a 787 Dreamliner aircraft had around 14 million lines of code whereas a level-five autonomous vehicle will have hundreds of millions of lines of code.

"This is the scale of the challenge we are dealing with," he said.

This was picked up by Armin



Andrew Macleod: "We want an open ecosystem."



Chet Babla: "Collaboration is key."



Martin O'Brien: "Model-based systems engineering is here to stay."

Lichtblau, Autosar embedded domain leader at Siemens.

"The software overall is increasing tremendously," he said, "with more lines of code than an aeroplane. The hardware has to execute all that code and the systems are more connected. The cars of the future will be interacting with each other."

Safety and security, he said, would be key for this.

"The systems have to be safe," he said. "And they need to be secure so nothing can affect the car when it is driving. Safety and security demands need to be verified very carefully. A bad design will lead to poor performance and high power consumption. To do this, you need a digital twin."

He said the big advantage of the digital twin approach was that different departments could start developing on the same platform at the same time.

"The digital twin really helps different people do verification at a very early stage," he said.

He acknowledged though that setting up a digital twin was complicated and took months of work.

"But it is worth it," he said.

Babla said sensor technology had to improve from the typical one error every six minutes through the one every one thousand hours, seen by some new designs, to one error every 11,500 hours that would be needed for level-three autonomous vehicles.

"Collaboration is key," he said. "No one company will be able to solve the problems on their own."

He said he had been in four autonomous vehicles, but they were really prototypes in that they did a good job but had a boot full of servers.

"That is not a deployable situation," he said. "We can get there today from a technical point of view but it is not commercially deployable."

Siemens is hoping its Pave 360 autonomous validation environment, launched earlier this year, will be a key enabler for developing autonomous vehicle platforms. This uses the digital twin of a chip to power the digital twin of an autonomous vehicle to drive in a digital twin of a city.

"It is really revolutionary," said David Fritz, automotive technology manager at Mentor.

A key element of it is how it digs deep in the dynamics of a vehicle, how even the mechanics will behave when particular actions are taken.

"Vehicle dynamics is a rally hard problem to solve," said Fritz. "When an autonomous vehicle makes a decision to move or stop, what it does depends on the features around it plus factors such as the weight in the car, the state of the tyres and so on. We can't do all this by driving vehicles around."

He said in theory hundreds of billions of kilometres would need to be driven to achieve a 95 per cent confidence level in an autonomous vehicle.

"Test driving alone cannot do this," he said. "But we now have an engineering solution to the problem. That is a digital twin. We are developing digital twins to show equivalence to physical platforms."

This means the system can run the so-called corner cases to test systems. Corner cases are the unusual events with which real drivers have to deal.

For example, what will the car do if it is driving over a bridge and there is an earthquake? This is impossible to test in the real world.

"We have an engineering level solution that can be applied to the problem," said Fritz. "This is how we will know an autonomous vehicle is ready. Pave 360 is the only platform in the world that we are aware of that has all the features We can test cases that are too dangerous or impractical to test in a real situation."



Armin Lichtblau: "The digital twin helps different people do verification at a very early stage."

David Fritz: "We have an engineering solution to the problem."



Nico Nagl, portfolio development executive at Siemens, said simulation allowed the creation of non-ideal worlds.

"You need non-ideal environments," he said. "You need bumpy roads, different weather conditions, water on the road, and so on. We need to bring these into the simulation. And the car needs to interact with other cars, pedestrians, the environment and so on."

Pave 360 also tackles the difficulty of protecting IP when collaborating. It lets users dictate which IP is visible to partners and customers.

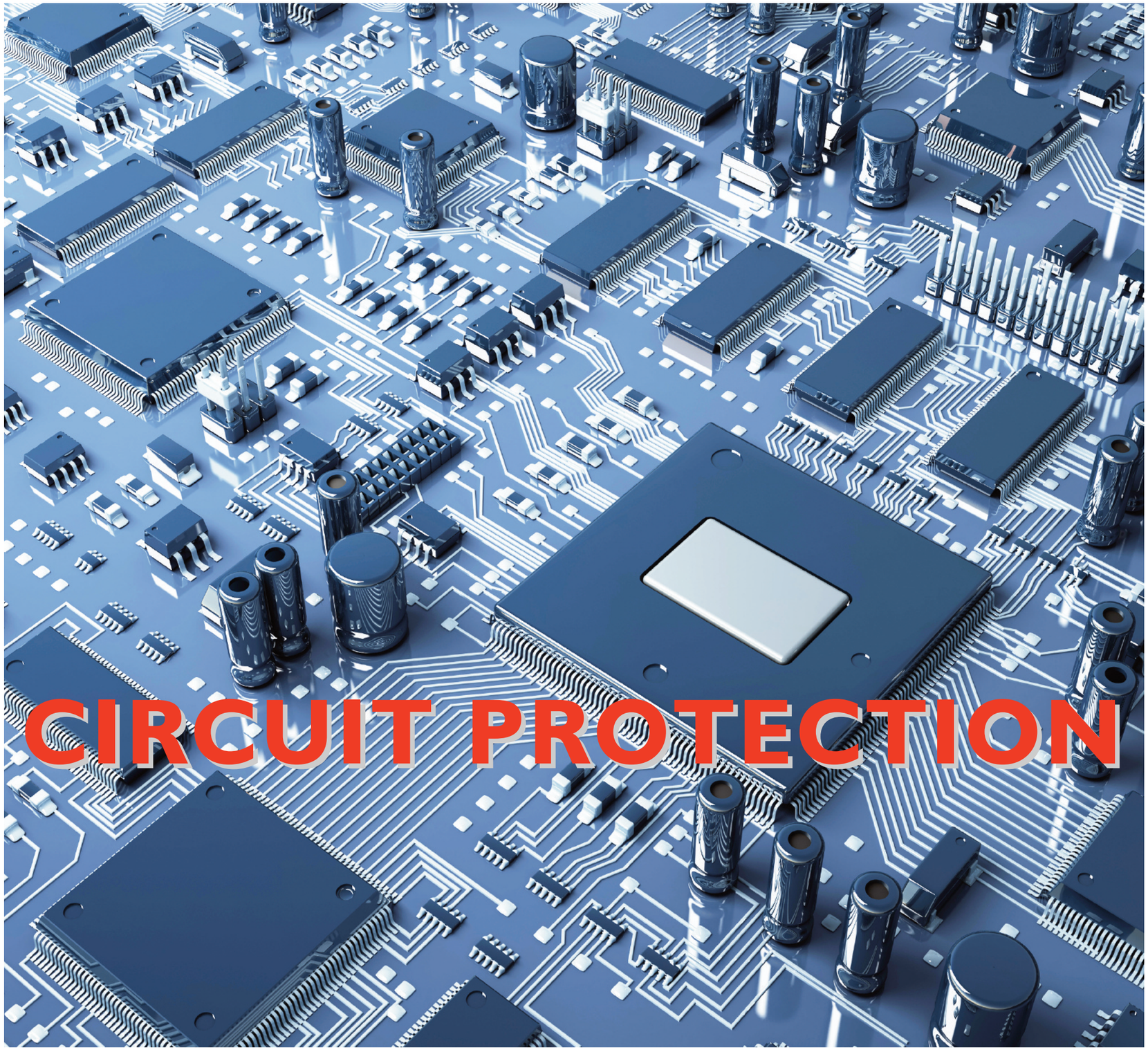
"This lets an OEM create an entire digital twin without putting anyone's IP at risk," said Fritz.

Siemens is working with a lead customer in Germany to help drive Pave 360 into its final state by going through various stages and proofs of concept. It is also talking with around sixty companies worldwide.



Nico Nagl: "You need non-ideal environments."

POWER TECHNOLOGIES



Bin Wu and Zhongming Ye explore power supply system designs for harsh automotive environments

Engineering resources continue to improve power management for the automotive market. Many technologies from that effort have resulted in advances in power supply efficiency, compactness, robustness and EMI performance.

Power supplies for automotive applications must perform without failure in harsh conditions; the designer must consider all exigencies, including load dump, cold crank, battery reverse polarity, double battery jump, spikes and other transients defined in LV124, ISO 7637-2, ISO 17650-2 and TL82066, as well as mechanical vibration, noise, extremely wide temperature ranges and so on.

Among the critical requirements in power supply specifications to meet automotive requirements are input transients, input voltage range, output voltage and current, low quiescent current (IQ), and electromagnetic interference (EMI).

Fig. 1 shows a traditional automotive electrical system where the engine drives an alternator. The alternator is essentially a three-phase generator, with its AC output rectified by a full diode bridge. The output of this rectifier is used to recharge a lead-acid battery and power 12V circuits and devices.

Typical loads include the ECU, fuel pump, brakes, fan, air conditioner, sound systems and lighting. Increasing numbers of adas are added to the 12V bus, including peripherals, IOs, DDRs, processors and their power supplies.

Electric cars change the picture somewhat. The engine is replaced with an electric motor, where a DC-DC converter converts a 400V high voltage lithium-ion (Li-ion) battery stack to 12V, instead of an alternator. Nevertheless, traditional 12V alternator devices are here to stay, along with their transient pulses, including fast pulses.

An engine runs at its peak efficiency in a narrow range of RPMs, so the steady-state output of the alternator and the battery voltage are relatively stable, say around 13.8V, under most conditions. Every circuit powered directly from the car battery must run reliably from 9 to 16V, but robust automobile electronic designs must also operate during outlier conditions that will inevitably occur at the most inconvenient time.

Although output of the alternator is nominally stable, it is not stable enough to avoid the need for conditioning before it powers the vehicle's other systems. Unwanted voltage spikes or transients are harmful to downstream electronic systems and, if not properly addressed, can cause them to malfunction or cause permanent damage.

In the past few decades, many automotive standards such as ISO 7637-2, ISO 16750-2, LV124 and

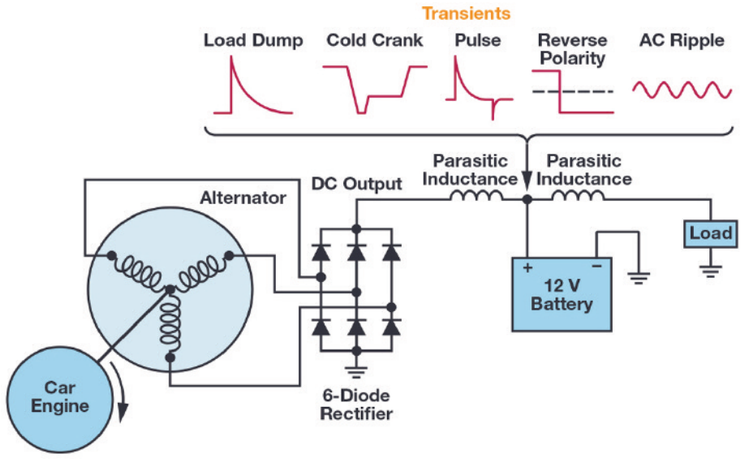


Fig. 1: Typical electrical system in a car

TL82066 have been produced to define the spikes and voltage transients that automotive power supplies will face, and set design expectations.

One of the most critical and challenging high voltage transients is load dump. In automotive electronics, load dump refers to the disconnection of the vehicle battery from the alternator while the battery is being charged.

During a load dump transient, the excitation field of the alternator remains high given its large time constant; the alternator still outputs high power even without the load. A battery is a big capacitor and will normally absorb the extra energy, but when it is disconnected due to a loose terminal or other issues, it can no longer provide this service. As a result, all the other electronics see the voltage surge and must be able to survive load dump events.

An unsuppressed load dump could generate voltages upward of 100V. Thankfully, modern car alternators use avalanche-rated rectifier diodes, limiting the load dump voltage to 35V, still a significant diversion from the norm. A load dump event can last up to 400ms.

Another high voltage event is jump-start. Some tow trucks use two batteries in series to assure effective jump starts to revive a dead car battery, so an automobile's circuits must survive the doubled nominal battery voltage of 28V for a couple of minutes.

Another voltage transient occurs when a driver starts an automobile and the starter draws hundreds of amperes of current from the battery. This pulls down the battery voltage for a short period.

In a traditional automobile, this happens only when the car is started by the driver, for instance, when one starts a car to drive to the supermarket and starts it again to drive back home. In modern automobiles with start-stop features to save fuel, start-stop events can occur a number of times on that supermarket trip, at every stop sign and every red light. The additional start-stop events put significantly more strain on the battery and starter than in a traditional vehicle.

Furthermore, if a start event happens on a cold morning, the starter draws more current than at higher ambient temperatures, pulling the battery down to 3.2V or lower for around 20ms. This is called cold crank.

There are functions that must remain active even in cold crank conditions.

The good thing is that, by design, such critical functions typically do not require significant power. Integrated multiple channel converters can maintain regulation even if their inputs drop below 3V.

ISO 7637-2 and TL82066 define many other pulses. Some have higher positive or negative

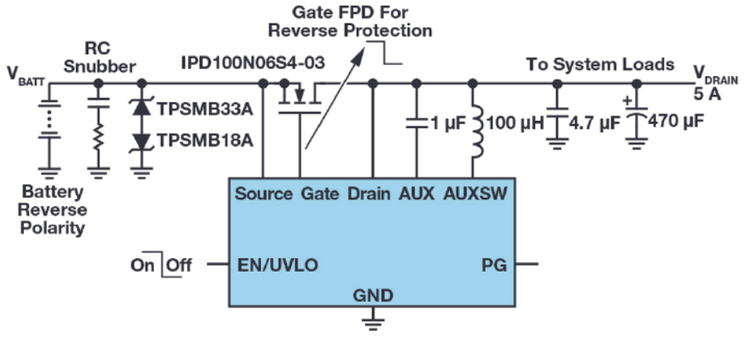


Fig. 2: Active rectifier controller response to battery reverse polarity

voltages but also higher source impedances. Those pulses have relatively low energy compared with the events described here, and can be filtered or clamped with proper selection of input TVS.

An active rectifier controller (see Fig. 2) with high input voltage rating, low quiescent current, fast transient response speed and low external FET voltage drop control can provide protection in 12V automotive systems with extremely low power dissipation.

Battery reverse polarity

Whenever the battery terminals are disconnected, there is a chance the car battery polarity is reversed by mistake and the electronic systems can be damaged from the negative battery voltage.

Blocking diodes are commonly placed in series with supply inputs to protect against supply reversal, but blocking diodes feature a voltage drop, resulting in an inefficient system and reducing the input voltage, especially during a cold crank.

An active rectifier controller can be an ideal diode replacement to the passive diode to protect the downstream systems from the negative voltages, as shown in Fig. 2.

Superimposed AC voltage

A common disturbance on the battery rail is a superimposed AC voltage. This AC component can be an artefact of the rectified alternator output or a result of frequent switching of high current loads, such as motors, bulbs or PWM controlled loads.

According to ISO 16750 and

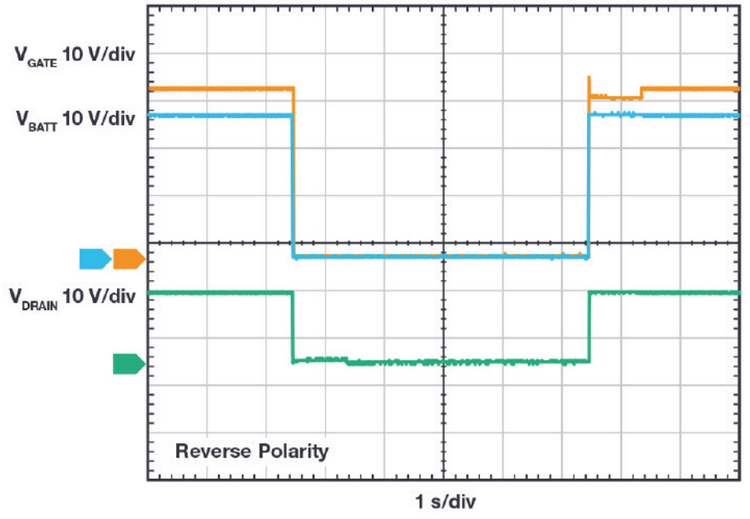


Fig. 3: Waveform of active rectifier controller response to reverse polarity

LV124, an ECU may be subjected to an AC ripple superimposed on its supply, with frequencies up to 30kHz and amplitudes of up to 6V p–p.

In Fig. 4, a high frequency AC ripple is superimposed on the battery line voltage. Typical ideal diode controllers are too slow to react, but the active rectifier controller generates high frequency gate pulses up to 100kHz to control external fets as needed to reject these AC ripples.

Pulses

High peak, narrow pulses that appear on the input of automotive electronic systems usually come from two sources: the disconnection of input power supply when there is inductive load in series or parallel; or the switching processes of a load influencing the distributed capacitance and inductance of a wire harness.

Some of these pulses could have high voltage peaks. For example, pulse 3a defined in ISO 7632-2 is a negative spike whose peak voltage exceeds -220V, while pulse 3b defines a pulse with maximum peak voltage of 150V, on top of the battery's initial voltage. Although they feature a large internal impedance and very narrow duration time, downstream electronics could be easily damaged if they see these pulses.

Two properly sized TVSs can be installed in the front end to suppress such spikes. In fact, some of the low energy pulses could be absorbed directly by filter effect of input capacitor and parasitic wire inductance.

Always-on systems

For always-on systems connected to the battery for weeks or months without a battery recharge, light load and no-load efficiency are, in some cases, more important than full load efficiency. Low quiescent current devices preserve

battery charge while withstanding difficult transient conditions and wide input voltage ranges, from 3 to 42V, and wide temperature ranges.

To optimise efficiency and maintain regulation at light loads and no load, a regulator can use burst mode operation. Between bursts, all circuitry associated with controlling the output switch is shut down, reducing the input supply current to a few microamps. In contrast, a typical buck regulator might draw hundreds of hundreds of microamps when regulating with no load, draining the battery orders of magnitude faster.

Burst mode efficiency at a given light load is mainly affected by the switching loss, which is a function of switching frequency and gate voltage. Because a fixed amount of energy is required to switch the mosfet on and off, and keep the internal logic alive, a lower switching frequency reduces gate charge losses and increases efficiency.

The switching frequency is primarily determined by the burst mode current limit, the inductor value and the output capacitor.

For a given load current, increasing the burst current limit allows more energy to be delivered during each switching cycle, and the corresponding switching frequency is lower. For a given burst current limit, a larger value inductor stores more energy than a smaller one, and the switching frequency is lower as well. For the same reason, a bigger output capacitor stores more energy and takes longer to discharge.

Fig. 5 shows a low IQ synchronous buck regulator that features high efficiency over wide input voltage and load current ranges. With integrated mosfets, this device can deliver up to 8A total output current at fixed output voltages of 3.3 or 5V. Despite the simple overall design and layout, this converter includes options that can be used to optimise the performance of specific applications in battery-powered systems.

EMI design

Automotive applications demand systems that do not produce electromagnetic noise that could interfere with the normal operations of other automotive systems. For instance, switching power supplies are efficient power converters, but by nature generate potentially unwelcome high frequency signals that could affect other systems.

Switching regulator noise occurs at the switching frequency and its harmonics.

Ripple is a noise component that appears at the output and input capacitors. Ripple can be reduced with low ESR and ESL capacitors, and low-pass LC filters. A higher frequency noise component, which is much more difficult to tackle, results from the fast switching on and off of the power mosfets.

With designs focused on compact size and high efficiency, operating switching frequencies are now pushed to 2MHz to reduce the passive component size and avoid the audible band. Furthermore, switching transition times have been reduced to the nanosecond realm to improve efficiency, by reducing switching losses and duty ratio losses.

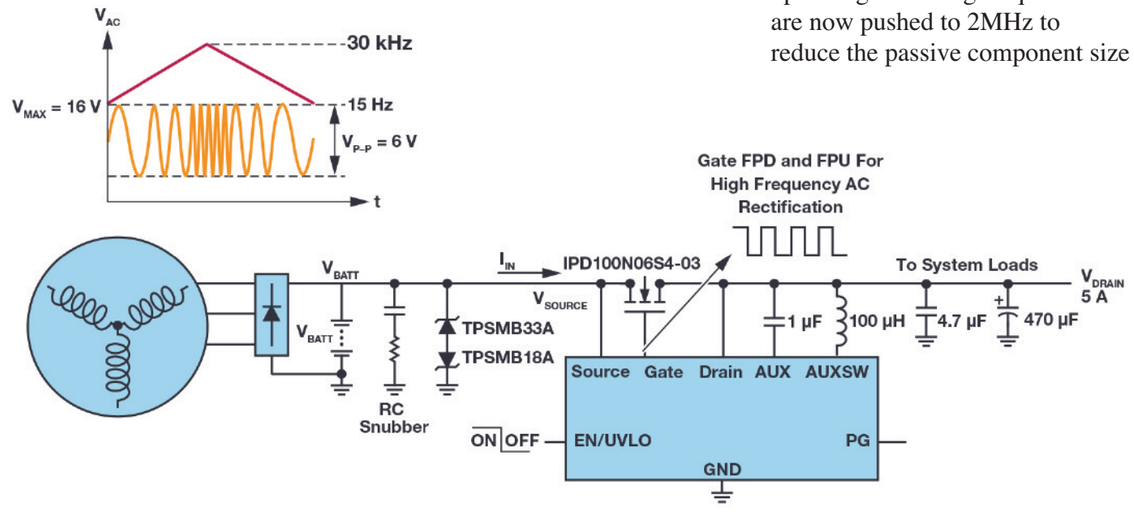


Fig. 4: Waveform of active rectifier controller response to superimposed alternating voltage

Parasitic capacitance and inductance from both the package and PCB layout play important roles in distributing noise, so if the noise is present, it can be difficult to eliminate. EMI prevention is complicated by the fact that switching noise covers the domain from tens of MHz to beyond GHz.

Sensors and other instruments subjected to such noise could malfunction, resulting in audible noise or serious system failure. Therefore, stringent standards have been set up to regulate EMI. The most commonly adopted one is the Cispr 25 class 5, which details acceptable limits at frequencies from 150kHz to 1GHz.

Passing automotive EMI regulation at high current usually means a complicated design and test procedure, including numerous trade-offs in footprint, total efficiency, reliability and complexity. Traditional approaches to controlling EMI by slowing down switching edges or lowering switching frequency come with trade-offs such as reduced efficiency, increased minimum on-and off-times, and larger size. Alternative mitigation, including a complicated bulky EMI filter, snubber or metal shielding, adds significant costs in board space, components and assembly, while complicating thermal management and testing.

Technology can address the EMI issue in innovative ways, enabling impressive EMI performance in high frequency, high power supplies. Such devices simplify board design and manufacture by incorporating the hot loop capacitors into the packaging.

For a buck regulator, the hot loop consists of an input capacitor and the top and bottom switches. Other noisy loops include the gate drive circuit and boost capacitor charge circuit.

In these devices, the hot loop and warm loop capacitors are integrated into the packaging and laid out to reduce EMI. This reduces the effect of final board layout on the EMI equation, simplifying design and manufacturing. Further peak EMI reduction can be achieved by using spread spectrum frequency modulation incorporated into these parts, making it easier to pass stringent EMI standards.

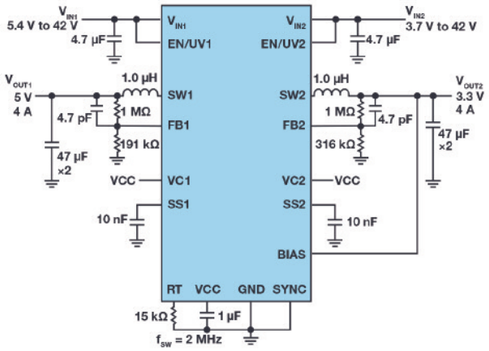
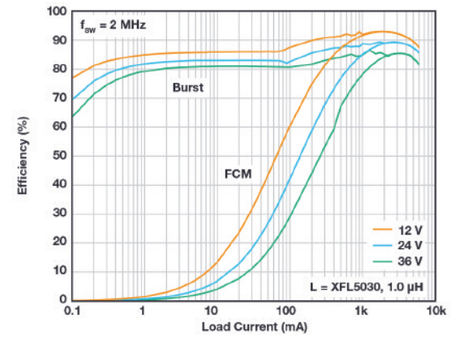


Fig. 5: Low IQ maintains very high light load efficiency to support always-on applications without significantly draining the battery



Conclusion

Automotive applications call for low cost, high performance, reliable power. The cruel under-the-bonnet environment challenges power supply designers to produce robust technology, taking into account many potentially destructive electrical and thermal events. Electronic boards connected to the 12V battery must be carefully designed for reliability, size and performance.



Bin Wu is an applications engineer and



Zhongming Ye a senior applications engineer at Analog Devices

DRIVER ASSISTANCE

WHERE TO LOOK

Mark Patrick looks at the proliferation of vision systems in modern automobiles



Every vehicle in motion contains one dangerous component – the human behind the wheel. The US-based National Highway Traffic Safety Administration (NHTSA) conducted a detailed survey of 2,189,000 road accidents and concluded that 94% (2,046,000) of these were the fault of the driver.

The most commonly identified driver faults (recognition errors) came from a lack of attention or from the driver being distracted in some way. Together these accounted for 41% of driver-caused accidents.

The safety of road users is of immense importance, and with this in mind the world's leading automobile brands are continuing to add features to their vehicles that can assist drivers, as well as developing more advanced systems that will, in the longer term, dispense with reliance on drivers entirely.

One of the most significant roles for the driver is to observe the surroundings and react accordingly, typically adjusting speed or direction. To do this, the driver must be aware of many things, including actual obstructions, potential obstructions, speed limits, other forms of road signage and weather conditions. If the vehicle is to help the driver, and eventually assume full responsibility through autonomous driving, then it must have the capacity to perform these tasks at least as well as a human can.

As car makers implement adas technology, sensors of all types are being incorporated into vehicle designs to provide the supporting data capture functions. However, it is vision-based sensing that is growing most rapidly, moving beyond simple reversing cameras and offering powerful and highly beneficial imaging.

Cameras

Forward-looking cameras are starting to see widespread uptake, not just in high-end but also in mid-range cars. Combined with appropriate image processing software, they can detect obstacles, and the coupling of this to a steering wheel sensor allows the system to determine whether the obstacle is within the vehicle's trajectory.

More advanced systems can plot the trajectory of a pedestrian and decide if it is likely to intersect with the path of the vehicle, and pre-empt any incident. The vehicle's adas can then offer a number of responses, ranging from a simple warning to taking evasive action, depending on its level of complexity.

Vision is far from being limited to forward-looking cameras, though. Many higher-end car models now have multiple cameras, thereby allowing a full 360-degree view of the vehicle when manoeuvring. While these can prevent minor but still expensive dings occurring, their real value lies in their ability to identify something that has moved close to the vehicle without the driver noticing, such as a pet or small child.

Not observing posted speed limits can, at best, lead to a hefty fine. However, it can potentially result in considerably more serious outcomes, such as a major accident causing injury or, even worse, one or more fatalities. Now, vision systems can recognise and read roadside speed signs, either using the existing forward-facing camera or, in some cases, a dedicated camera unit.

In-vehicle responses could vary from displaying a replica of the sign in the driver's line of vision, to sounding an audible alert if the speed limit is exceeded, or possibly capping the speed of the vehicle so the limit is always complied with.

As lighting technology evolves, moving away from traditional lamps to LED-based illumination, both for street lighting and for vehicle headlamps, so flicker is becoming a challenge for vision systems. Due to human persistence of vision, this is not noticeable to the driver, but it can show as dark bands on periodically captured images, making character recognition such as the numerals on a speed limit sign difficult.

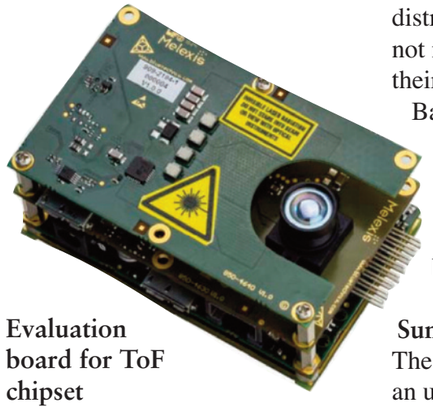
Advanced image capture algorithms will acquire several images almost instantaneously and merge these to give a high-quality composite image that can be read accurately. This technique, commonly known as flicker mitigation, is now being employed in automotive image sensors.

Cameras are not just for outside

the vehicle; they are also being used inside it. With the driver continuing to play a significant role in vehicle control for the moment at least, imaging technology is needed to monitor the driver. This makes it possible to ensure the driver is ready to react quickly to an impending situation and, if that is not the case, the adas can intervene.

The camera will continuously monitor the driver's face and head position, and through artificial intelligence (AI) assess the level of drowsiness, as well as traffic attentiveness, by confirming that the driver is checking the mirrors frequently. If the driver is becoming inattentive or noticeably tired, reminders can be given, or a rest break suggested. Such monitoring can also be used to gauge the height and size of the person in the front passenger seat to enable appropriate airbag deployment during a crash.

The driver camera may add convenience into this equation too. Simple face recognition software can recognise one driver from another and set the cabin preferences including seat position, steering wheel position, mirrors and cabin temperature to pre-configured values, resulting in a more comfortable driving environment. In addition, imaging can be applied to the vehicle occupants in general, for example to check they are comfortable and adjust the climate control if they are not.



Evaluation board for ToF chipset

Vision technology

Little, if anything, in the technology arena stays still, and this is indeed true of the constantly evolving vision sensing hardware and accompanying software deployed in cars. As in-vehicle communication migrates from Can bus to Ethernet, higher-resolution video at accelerated frame rates can be accommodated, thereby improving image quality and resulting in greater safety.

Vehicle control

The use of vision systems in vehicles is being extended to other innovative applications. As car makers seek to provide intuitive human machine interfaces (HMIs) to ever-more-complex vehicle systems in the limited space available within the cabin, complementing existing controls, gesture-based HMIs allow the driver to give input commands without being a source of distraction while driving, as it is not necessary for them to take their eyes off the road.

Based on time-of-flight (ToF) technology, a chipset can enable a simple, modular design for 3D vision systems suitable for creating gesture-based HMIs.

Summary

The automotive industry is seeing an unprecedented amount of technology being added to vehicles to make them more economical, more convenient and, most importantly, safer.

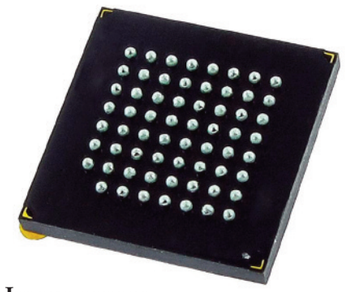


Image sensor

Advanced sensor technology is already augmenting the driver's capabilities through adas and, as further technological progress is made, automated systems will eventually supplant the driver.

Sensor types are proliferating, and through sensor fusion they are starting to work together to ensure safe operation at all times. Vision is key to the vehicles of the future, and many mid-range models now include multiple vision sensors to sense the world around them, read roadside signs and monitor the driver.

Image sensors are offering ever-greater resolution levels, to allow details to be identified, while advances in pixel technology allow accurate operation to be maintained even in the low light conditions often experienced when driving at night or in bad weather.

Mark Patrick is technical marketing manager at Mouser Electronics





ACCIDENT PREVENTION

Benjamin Wagner discusses deep learning in driver assistance systems

Each year about 1.35 million people die in traffic accidents and another 20 to 50 million are injured, according to a report by the World Health Organisation. One of the main causes is driver inattention.

Consequently, many automotive manufacturers offer driver assistance systems that detect tiredness. But it's not just microsleep at the wheel that causes accidents. Talking or texting on smartphones, and eating or drinking while driving cause high risk.

Until now, driver assistance systems have been unable to identify these activities. Therefore, we ran a series of tests towards automatically recognising and categorising mobile phone use and eating and drinking. Images were captured with infra-red cameras and used for machine learning by several convolutional neural network (CNN) systems. This created the basis for a driver assistant that can reliably detect various scenarios at the wheel, and warn the driver of hazardous behaviour.

For years, the automotive industry has installed systems that warn in case of driver fatigue. These driver assistants analyse, for example, the viewing direction of the driver, and automatically detect deviations from normal driving behaviour.

Existing warning systems can only correctly identify specific hazard situations. But during some activities such as eating, drinking and phoning, the driver's viewing direction remains aligned with the road ahead.

For that reason, the tests identified a range of driver postures so systems could automatically detect the use of mobile phones and eating or



Smartphone distraction is a major cause of accidents

drinking. For the system to identify all types of visual, manual and cognitive distraction correctly, various CNN models were tested with deep learning and trained with the collected data.

Image dataset

In the test setup, two cameras with active infra-red lighting were positioned to the left and right of the driver on the A-column of a test vehicle. Both cameras had a frequency of 30Hz and delivered 8bit grey-scale images at 1280 x 1024 pixel resolution. The cameras were also equipped with an IR long-pass filter to block out most of the visual spectrum light at wavelengths under 780nm.

This ensured that the captured light came primarily from the IR LEDs and that their full functionality was assured during day and night time.

In addition, blocking visible daylight prevented shadow effects in the driver area that might otherwise have led to mistakes in facial recognition. A Raspberry Pi 3 Model B+ sent a trigger signal to both cameras to synchronise the moment of image capture.

With this setup, images were captured of the postures of 16 test persons in a stationary vehicle. To generate a wide range of data, the test persons differed in gender, age and headgear, as well as using different mobile phone models and consuming different foods and beverages.

Five distraction categories were set up to which driver postures could later be assigned. These were: no visible distraction; talking on smartphone; manual smartphone use; eating or drinking; and holding food or beverage.

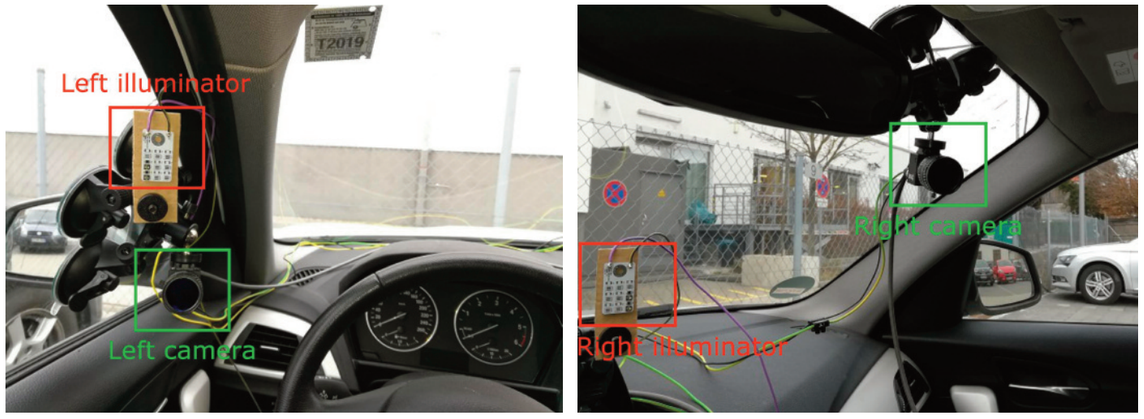
For the tests, the test persons were instructed to switch between these activities during simulated driving. After capture, the images from the two cameras were categorised and used for model training.

Classification systems

Four modified CNN models were used to classify driver postures: ResNeXt-34, ResNeXt-50, VGG-16 and VGG-19. The last two are widely used in practice, while



Eating or drinking can be a high risk while driving



Cameras with active infra-red lighting were positioned to the left and right of the driver

ResNeXt-34 and ResNeXt-50 contain a dedicated structure for processing of parallel paths. To train the system, 50 epochs were ran using an adaptive learning rate optimisation algorithm.

In each epoch, the CNN model had to assign the test persons' postures to the defined categories. With each step, this categorisation was adjusted by a gradient descent method, so the fault rate could be lowered continuously.

After model training, a dedicated test dataset was used to calculate the error matrix, which allowed an analysis of the fault rate per driver posture for each CNN model.

The use of two cameras, each with a separately trained CNN model, enables ideal case differentiation for the left and right side of the face. Thanks to this process, it was possible to identify the system with the best performance in recognising the use of mobile phones and consumption of food and beverages.

Evaluation of the results showed the ResNeXt-34 and ResNeXt-50 models achieved the highest classification accuracy, 92.88 per cent for the left camera and 90.36 per cent for the right. This is competitive with existing methods for detection of driver fatigue.

Using this information, the training database was extended and now contains around 20,000 labelled eye data records. Based on this, it is possible to develop an automated vision-based system to validate driver monitoring systems. Experts are already planning another step to reduce the fault rate further.

To improve accuracy, other CNN models will be used in the next project. Besides evaluation of different classification models, there will be analysis of whether the integration of associated object positions from the camera image can achieve further improvements.

In this context, approaches will be considered that are based on bounding box detection and semantic segmentation. The latter enable, in addition to classification, different levels of detail regarding the localisation of objects. In this way, the accuracy of driver assistance systems can be improved for the automatic detection of driver distraction.

Benjamin Wagner is senior consultant for driver assistance systems at Arrk Engineering





Seeing double

Predictive simulation becomes Industry 4.0 technology for Nissan

Nissan Motor in the UK has been developing predictive digital twins to boost plant efficiency and optimise its business decision-making.

The car maker has been using Warwickshire firm Lanner's Witness Horizon predictive simulation software. Industrial engineers have created models to answer key operational and strategic questions, and to help facilitate Nissan's journey into Industry 4.0.

The first challenge was meeting new powertrain production targets. This meant identifying the required process improvements that could double production rates.

Nissan was preparing to launch an updated model of its Leaf electric car, featuring a more advanced motor. To meet projected consumer demand, the Sunderland factory needed to double its powertrain throughput from five jobs per hour to ten. The industrial engineering team wanted to identify potential bottlenecks with an updated production design, homing in on the process improvements that would be required to facilitate the increased output.

The outcome was evidence-based decision-making that helped hit targets.

Using predictive simulation, the team identified a crucial bottleneck in the sealing process. Once the seal is put on the motor unit, it has to cure for 15 minutes before it can be leak tested. Even after modelling several change scenarios, this blockage still couldn't be eliminated.

To overcome the issue, engineers used the model to experiment with various countermeasures.

The answer was to implement another loop that provides additional powertrain unit storage capacity. This increased throughput while still providing the required cure time before seal testing.

Nissan is now using this model for additional planning, running scenarios that facilitate 15 jobs per hour to be ready for future production ramp-up.

Leak test failure rates

Nissan also wanted to de-risk production during the battery tree leak test stage. Another element of planning for the Leaf involved analysing the leak testing process for the battery tree. The team wanted to know the maximum allowable leak test failure rate that would still result in hitting performance targets.

Here, accurate knowledge helped fulfil demand and meet key performance indicators. The predictive digital twin was used to model production scenarios with varying leak test failure rates. It concluded that the failure rate could not exceed 5.2% without affecting throughput. This has allowed engineering teams to plan effectively to fulfil demand.

Cylinder head machining

As part of vehicle manufacture, cylinder heads undergo a process of machining, cleaning and then second-stage machining. For part of this time, the head is attached to a pallet. Nissan's engineers were planning to order new pallets but, with a significant cost for each, they wondered if the facility could operate with a reduced number without negatively affecting the current throughput rates.

The digital twin of the cylinder head machining line was used to run various scenarios for different pallet volumes, analysing factors such as inputs, tack time and volumes. The model showed that the minimum viable stock of 70 pallets would be required to operate at full capacity and little risk of bottlenecks, significantly less than the anticipated 100. The benefits equated to an overall savings of £22,000.

Bumper paint

The Sunderland plant's bumper paint facility receives components from two production lines, managing to process parts for multiple car models and the wide range of paint colours. Bottlenecks were starting to occur because the facility was regularly running out of storage rack space. Engineering wanted to know how many racks were required to avoid having to stop the paint line.

Using a digital twin of the bumper paint line, developed using the Witness Horizon software, Nissan created a visual model connected to spreadsheet production data. The predictive digital twin ran various scenarios based on the different car models arriving into the paint shop and determined the optimum number of storage racks to ensure neither production line would be at risk of stopping. The planning department has now evolved the digital twin to account for new vehicle release plans so that requirements can be optimised continually.

Expansion

Paint guard film is applied to certain car panels, depending on destination and application, to protect the finish and increase durability. In preparation for launching the new Infiniti model, the trim and chassis engineering team were concerned that a paint guard film station might be required to meet the planned demand.

A predictive digital twin was used to simulate the production control schedule. The team ran scenarios for paint guard film requirements and determined that the existing facilities had enough capacity to cope with the projected increase in demand. Using the existing equipment meant that capital expenditure in a new station, which would have required a £25,000 investment, was avoided with confidence.

"We're quite a lean department and working with Lanner and Witness has helped us develop models which are now used regularly to make business decisions across Nissan in the UK," said Martin Perkins, industrial engineer at Nissan. "Thanks to the modelling, we've been able to implement steady improvements in our processes, and simulation has become a key part of Nissan's adoption of industrial IoT and smart technology."



Nissan Leaf being built at Sunderland plant



Time to pause?

David Emm questions whether the industry is moving too quickly on the road to autonomous vehicles

In the UK, the Department for Transport recently claimed it wants to see fully autonomous cars tested on roads by 2021. Astonishingly, this expectation was set out after a fatal crash involving a self-driving car in Arizona.

The Can communications infrastructure used in cars today was designed back in the 1980s. It was developed for exchanging information between different microcontrollers. Essentially, it is a peer-to-peer network, and an old one at that.

The main issue here is that these networks were not built with security in mind, as it was not a key concern back then. As time has gone on, modern-day functionality has been layered on top of existing functions, all connected to the Can. This gives it no access control or security features but, instead, leaves access to cars potentially open to criminals.

While there are no real-world hacks that have been executed this way, it has been proven possible. For example, in 2015 two researchers and a journalist were able to use wireless technology to drive a Jeep Cherokee off the road. As a result of this flaw, half a million cars were recalled.

It is an example of emerging technologies being layered on top of old infrastructure, without fully considering the security implications.

Potential security issues don't just lie in the underlying communications network of the car itself. There's also the possibility of an attacker infecting a driver's smartphone and hijacking any apps they use to control functions on the car, for example to lock and unlock it.

Who needs humans?

Following the fatal incident in Arizona last year, it was predicted that it would be many years until autonomous cars replace human drivers. The reality is, driverless cars will not or should not ever replace human drivers in the way people think of them doing so now, where nearly everyone will continue to drive a private car, but it will be self-driving. However, the issue of how to implement the technology is something for society ultimately to decide, whether this takes the form of private vehicles, or a co-ordinated public transport system. Neither should remove the human aspect of vehicles.

People are becoming more apprehensive when it comes to driverless cars, where safety is paramount, and rightly so. Historically, driving has always been an aspect of life where human control has been essential, so the idea of watching a film, or sleeping, while a car transports them, feels understandably wrong to many people.

There are various levels of autonomy with self-driving cars ranging from add-on features such as parking assistance through to completely driverless cars. A grey area lies between the two, where the driver has very little to do, but has responsibility for the vehicle and might need to take control at some point. In the latter scenario there's a danger the driver may switch off because they don't feel required to be in full control and might therefore be unable to regain control in an emergency.

The driverless car fatality in Arizona shows there is a very real danger with autonomous vehicles, and it is therefore reasonable to question whether it is wise to resume the use of them so quickly after the incident.

Safety first

There are real safety concerns about pedestrian and driver safety, as recent stories surrounding autonomous car testing have demonstrated, which society needs to tackle before driverless cars are launched.

There's also a moral or ethical issue to consider. Christian Wolmar raised the issue of the Holborn problem: if driverless cars are programmed to stop when they sense a pedestrian, what happens when they are confronted with a mass of people milling across a busy road? Will they wait all day? Or will they be programmed to operate with a lower safety bar? Or if the car is given the chance to choose to avoid hurting pedestrians or the passenger in the car in the lead up to an accident, how and who will it choose? A car isn't able to make moral-based decisions on its own.

Ethics aside, in terms of cyber security, it is important to remember that nothing can be 100% secure. Just like housework, security is never done – people need to repeat continually the process of vacuuming and dusting as the dirt will be back next week. This same logic applies to securing the increasingly advanced technology in modern cars. There are still many unanswered questions and unconsidered scenarios, which need to be ascertained before even starting to consider loosening the reigns on bringing autonomous cars to roads.



David Emm is principal security researcher at Kaspersky Lab



Autonomous cars may have to make ethical decisions

Rugged platform provides modular building blocks

For distributed power requirements in embedded computing applications, Elma Electronic has introduced the Elos Compact PCI Serial platform. The rugged chassis provides modularity with an ecosystem of building blocks from multiple vendors for railway, automotive and industrial use.

It can ship with a choice of a two- or three-slot backplane, three enclosure sizes and four power supply configurations. The enclosure is available with outputs of 12, 24 or 48V as well as output power up to 75W.

These configurations enable custom-built designs for rugged and mobile applications without proprietary interfaces or form factors.

A typical configuration consists of a rugged enclosure, backplane, power supply and the Compact PCI Serial CPU, peripheral and mezzanine cards.



The enclosed system is constructed of extruded aluminium and can be passively or actively cooled, offering up to three 3U slots as well as a bay for the power supply.

Typically featuring a three-slot backplane, it can have a two-slot backplane with a system slot in the centre of the housing for applications where a mezzanine card is stacked on the CPU.

Toolkit boosts machine-learning development environment

NXP has expanded its eIQ software machine-learning development environment with an automotive-grade deep learning toolkit, eIQ Auto.

The toolkit aims to help users move quickly from a development environment to AI application implementations that meet automotive standards. It enables the application of deep learning-based algorithms to vision, driver replacement, sensor fusion, driver monitoring and other evolving automotive applications.

Users can develop for automotive production on desktop, cloud and GPU environments and deploy their neural network onto a supported S32 processor. The toolkit and automotive grade inference engine enable deployment of neural networks in applications with intensive safety requirements. A good example is speeding up the transition from traditional computer vision algorithms to deep learning-based algorithms in vision systems.

Deep learning holds the promise of delivering better accuracy and better maintainability in object detection and classification over traditional computer vision algorithms, but the barriers to full automotive implementation bring complexity and steep costs.

The toolkit aims to help reduce time to market by lowering the investment costs required to select and programme embedded compute engines for each layer of a deep learning algorithm.

The automated selection process is said to lead to 30 times higher performance for given models compared with other embedded deep learning frameworks.

This performance is achieved by optimising the use of available resources and reducing time and development effort. These dividends allow developers to evaluate, fine tune and deploy their applications with increased overall performance.

The inference engine was developed in accordance with functional safety requirements and is Automotive Spice compliant.

The S32V processors offer functional safety supporting ISO 26262 up to Asil C, IEC 61508 and DO 178.

Multiple execution options are supported with unified API and runtime backend selection.

A Spice compliant inference engine can optimise performance by scheduling tasks on the most efficient accelerator.

Magnetic gear tooth sensor IC

A magnetic gear tooth sensor IC from Allegro Microsystems can provide incremental position for electric vehicle traction motors operating up to 30,000 RPM.

The ATS17501 addresses engineering difficulties such as vibration at start-up and running mode, high rotational speed, mechanical space constraints, high operating temperatures, and ISO 26262 safety requirements.

It can achieve switching up to 40kHz for 30,000 RPM operation. It provides an incremental encoded output with speed and direction information on a dual channel interface. Algorithms suppress undesired output pulses at start-up and running mode.

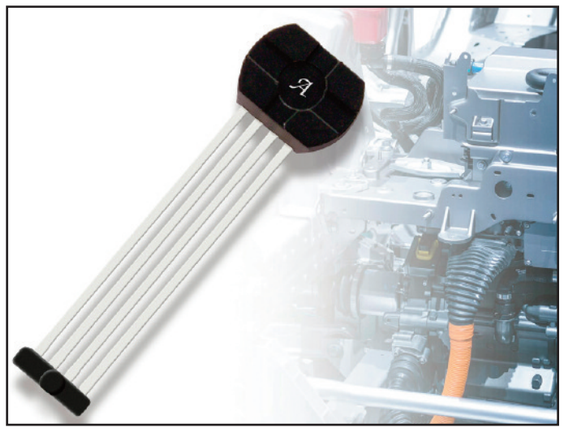
The patented integrated magnet package reduces design complexity and enables smaller motors.

Operating temperature is up to +160˚C.

The device incorporates digital signal processing for vibration robustness and is built on the firm's SolidSpeed digital architecture to provide electric motor commutation information.

The over moulded four-pin SIP SG package integrates a magnet to optimise performance over air gap and temperature.

Using a certified ISO 26262: 2011 safety design process, the device incorporates real-time diagnostics to achieve an Asil-B (D) rating as a safety element out of context, pending assessment.





Inductors

Three low profile, high current inductors come in Vishay's smallest automotive-qualified case size to date. The 3.3 by 3.3mm 1212 case can save space in adas and sensor applications.

Thee IHLP 1212AZ-5A, 1212BZ-A1 and 1212BZ-5A operate from -55 to +155˚C and have profiles of either 1.0 or 2.0mm.

The AEC-Q200 qualified devices are optimised for energy storage in DC-DC converters up to 5MHz. They attenuate noise in high current filtering applications up to the SRF of the inductor.

The inductors are designed for filtering and DC-DC conversion in adas, sensor, entertainment and navigation systems, in addition to noise suppression for medium current filter applications.

Packaged in a 100% lead (Pb)-free shielded, composite construction that reduces buzz, the devices resist thermal shock, moisture and mechanical shock, and handle transient current spikes without saturation.

Inductance is 0.1mH to either 1.0 or 3.3mH.

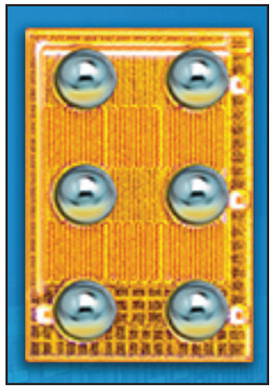
Lidar fet meets AEC-Q101

EPC has achieved AEC-Q101 qualification for its 15V EPC2216 fet for lidar applications in self-driving cars and other time-of-flight uses such as facial recognition, warehouse automation, drones and mapping.

The 15V, 26mΩ, eGaN fet has a 28A pulsed current rating in a 1.02mm^2 footprint. It is suitable for firing the lasers in lidar systems because the fet can be triggered to create high-current with short pulse widths.

The short pulse width leads to higher resolution, and the size and cost make it suitable for time-of-flight applications.

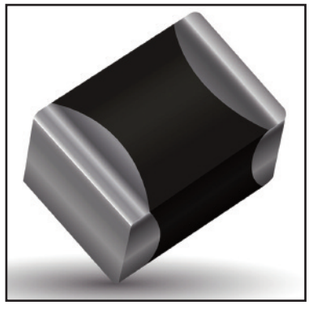
For AEC-Q101 approval, the fets had environmental and bias-stress testing, including humidity testing with bias, high temperature reverse and gate bias, and temperature cycling.



Varistors lower clamping to working voltage ratios

Automotive-qualified multilayer varistors (MLVs) from AVX are designed to exhibit lower breakdown- and clamping-voltage to working-voltage ratios than standard varistors.

Comprised of zinc-oxide-based ceramic semiconductor devices with nonlinear, bidirectional voltage-current characteristics similar to those of back-to-back Zener diodes, they have more current and energy handling capabilities.



The new VLAS low-clamp TransGuard MLVs combine bi-directional overvoltage circuit protection and broadband EMI and RFI filtering functions in a surface-mount device that is qualified to AEC-Q200.

This means they can extend the multifunctional advantages of varistor technology to sensitive automotive electronics applications that require tighter clamping voltage performance for overvoltage protection, as well as the optimisation of physical space, including in infotainment systems, ECUs, microcontrollers and displays.

They have less than 1ns response times to ESD strikes. They don't require any current or energy de-rating from -55 to +125˚C.

There are four chip sizes (0603, 0805, 1206 and 1210) rated for 16V DC working voltages, 35V DC maximum (30V DC typical) clamping voltages, 0.1 to 1.6J energy ratings, 0.7 to 3J load dump energy, 50 to 500A peak current ratings, and 400 to 5000pF capacitance.

They also have RoHS-compliant nickel-barrier-over-pure-tin terminations compatible with lead-free solder processes and are compliant with the ESD performance requirements defined in AEC-Q200, IEC 61000-4-2 and ISO 10605.

They are supplied in tape-and-reel packaging.

Schottky diodes operate at high temperature

Eight 200V low leakage current Schottky barrier diode (SBD) from Rohm are optimised for use in powertrains and EVs.

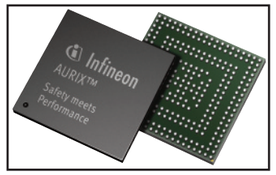
The RBxx8BM NS200 expands the RBxx8 line of SBDs enabling high temperature operation.

Replacing rectifier and fast recovery diodes (FRDs) typically used in vehicles, the SBDs make it possible to improve forward voltage characteristics by up to 11% lower than conventional FRDs. This reduces power losses and allows smaller package designs by lowering heat generation.

They use a barrier metal optimised for high temperature that improves leakage current. This ensures safe operation at high temperatures, eliminating the possibility of thermal runaway.

The firm is developing medium power packages, with plans to decrease mounting area by up to 71% by replacing 5.9 by 6.9mm FRDs with 2.5 by 4.7mm products.





77GHz radar microcontroller

An addition to Infineon's Aurix microcontroller family will address automotive 77GHz radar applications such as high-end corner radar systems for adas and automated driving.

Features include a signal processing unit, large sram dedicated to radar and four TriCore processors running at 300MHz with two additional lock-step cores.

The TC3A's signal processing unit, called the SPU 2.0, is an evolution of the firm's accelerator for radar processing with reduced latencies for fast Fourier transform processing, extended capability for interference mitigation and different modulation schemes allowing users to improve radar resolution at lower cost.

There is 6Mbyte embedded sram to store data during processing, plus high-speed radar MMIC interface with up to 600Mbit/s and hardware security module compliant with Evita specs.

Samples will be available to selected users in 2022.

Module tackles 5G communications

LG Innotek has developed a communication module for automotive based on Qualcomm's Snapdragon chip.

The module uses 5G mobile telecommunication technology to enable transmission of data between a vehicle and a cellular base station and wireless network connection. It combines a communication chip, memory and RF circuit and is for mounting inside a vehicle or in a communication device on the roof.

The module makes possible the sharing of real-time traffic information, precise location measurement, V2X communication and transmission of larger amounts of data.

LG used proprietary RF circuit design technology, high precision and density modular technology as well as heat resistant materials.

Latency is 1ms or less, which is one tenth that of an LTE module.

For example, if an autonomous vehicle driving at 100km/hr detects an obstacle and activates the urgent braking function, braking starts after the vehicle moves 1.4m with an LTE module, but with a 5G module, braking starts after the vehicle moves 2.8cm because the latency is lower.



It can withstand and is not easily deformed by the high heat generated by 5G networks as well as direct sunlight on the vehicle roof. The module uses plastic materials that are less sensitive to temperature change.

Size is 40mm wide by 50mm long and 3.5mm thick.

It contains about 480 components.

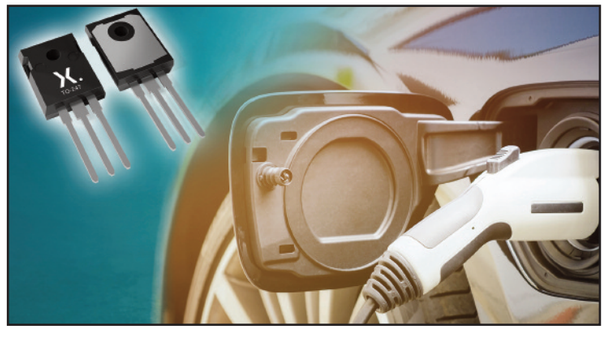
It can be used regardless of the region or vehicle type because it follows 3GPP release 15.

GaN fet

Nexperia has entered the gallium nitride (GaN) fet market with the 650V GAN063-650WSA with a gate-source voltage of ±20V and a temperature range of -55 to +175˚C.

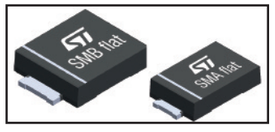
RDS(on) is down to 60mΩ and its fast switching improves efficiency. Electric vehicles are among the target markets.

The firm's GaN-on-silicon process is robust and scalable as wafers can be processed in existing silicon fabrication facilities. More, this device is available in the standard TO-247.



TVS diodes in 1mm high packs

Transient-voltage-suppression (TVS) diodes from ST Microelectronics handle 600 and 1500W transient power in SMB flat, and 400 and 600W in SMA flat, packages that are 1.0mm high.



The 1500W SMB flat package has transient-power capability equivalent to that of conventional devices in SMC packages, in a footprint less than half the size. The 400 and 600W devices are footprint-compatible with alternatives in conventional SMA and SMB packages.

Leakage current is said to be five times lower than other TVS diodes on the market.

Standoff voltages are from 5.0 to 188V, to serve applications such as telecom equipment, consumer products, power tools, e-bikes, drones, robots and automotive electronics. Industrial-grade and AEC-Q101-qualified parts are available.

The 400 and 600W devices are in production.

LDOs meet AEC-Q100

Two low-dropout (LDO) linear regulators from Diodes comply with AEC-Q100 grade one.

The AP7315Q and AP7343Q deliver 150 and 300mA, respectively, and suit any automotive application that requires tight voltage regulation across operating conditions, such as point-of-load power supplies in adas, RF communications, infotainment systems and cameras.

With full production part approval process (PPAP) capability, the regulators can be used in automotive applications that require a -40 to +125˚C temperature rating.



They can provide practical alternatives to switching regulators.

As well as current limiting and short-circuit protection, the LDOs have an enable input that allows them to be switched off when not required.

While in use, they have a quiescent current of 35μA.

Both are available with or without an output capacitor discharge feature, which is often required to protect, during shutdown, sensitive loads such as cmos image sensors.

Universal flash memory

Kioxia has begun sampling its 512Gbyte automotive universal flash storage (UFS) Jedec 2.1 embedded memory.

It supports a temperature range from -40 to +105˚C and meets AEC-Q100 grade two requirements.

The device joins the company's existing line of automotive UFS, which includes capacities of 16, 32, 64, 128 and 256Gbyte.

Target applications include autonomous vehicles, infotainment systems, digital clusters, telematics and adas.

It integrates the company's Bics 3D flash memory and a controller



in one package and contains functions suited to the requirements of automotive applications including refresh, thermal control and extended diagnosis.

The refresh function can be used to refresh data stored in UFS and helps extend the data's lifespan. Thermal control protects the device from overheating in the high-temperature circumstances that can occur in automotive applications. And the extended diagnosis function helps the host processor understand the device's status.

Inductor works up to 150˚C

A chip bead inductor from Taiyo Yuden has an operating temperature up to +150˚C and is for suppressing high-frequency noise from automotive electrical systems with increasing number of electronic control units.

The type T, FB TH1608 AEC-Q200 qualified noise suppression component measures 1.6 by 0.8 by 0.8mm.

This product is a noise suppression component for power lines used in powertrains and other automotive components such as engines and transmissions. It can also be used in communications infrastructure devices such as servers and base station communication devices.

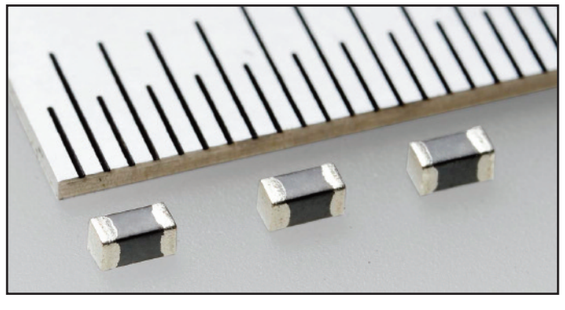
Based on the firm's internal structure and material technology, it is suitable for wideband noise suppression up to gigahertz frequencies.

Commercial production has started at a rate of ten million units per month.

Vehicles are being equipped with an increasing number of ECUs, typified by adas units.

Each electronic circuit requires EMC measures to reduce external and internal noise and to prevent malfunctions or other glitches.

In addition, since more ECUs are installed in the engine bay, subject to high temperatures, electronic components used in the ECUs must possess high heat resistance.



Antenna chamber tests radar chips

Rohde & Schwarz is helping develop automotive radar chips with a test chamber, previewed at the recent Productronica in Munich.

The ATS1500C antenna test system is a test chamber for radar testing, offering indirect far-field testing performance.

It is for use with the AREG100A radar echo generator for precise radar target simulation at various distances.

Together, they form an indirect far-field tester for reproducible verification of radar sensors during the R&D and validation phase in a lab setup.

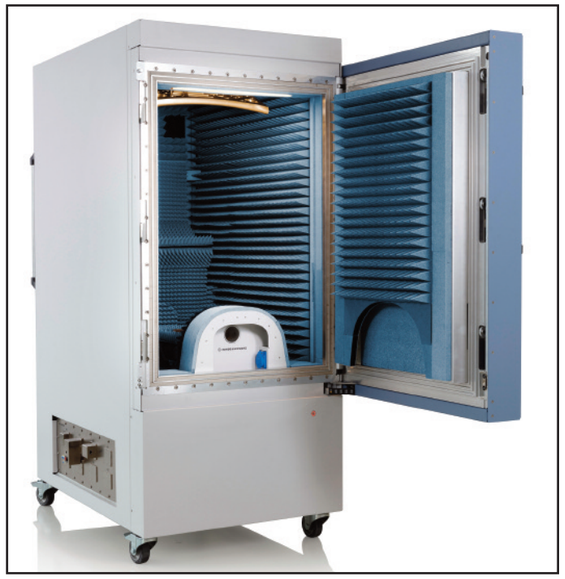
This combination enabled the calibration and verification of Uhnder's integrated 4D digitally modulated automotive radar-on-chip (RoC).

The ATS1500C has an accurate compact antenna test range reflector, generating a 30cm diameter quiet zone for testing from 77 to 81GHz.

Its 3D tilt-tilt positioner permits testing of premium automotive radars. An absorber layout eliminates ghost targets during simulation.

Start-up Uhnder is launching an automotive RoC for adas use. The technology behind the 4D digitally modulated radar chip integrates 192 virtual channels, a leap from the eight to 24 virtual channels used in standard radars.

A higher number of detections per frame makes it possible to track and classify objects with a processing power of more than 20Tops, despite using less than 8W of power.



The RoC also pioneers high contrast resolution technology, which improves range and angular resolution and makes it possible to separate small radar reflectors from large reflectors in proximity.

This permits a more accurate and safe reaction time than current radar chip technology and paves the way for adas functions for future driverless vehicles.

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