VEHICLE electronics

The monthly magazine for automotive electronics engineers

Nvidia bids to be self-driving brain

Nvidia hopes to be at the heart of future autonomous vehicles with the Drive Thor centralised computer.

Targeting 2025 model year vehicles, it achieves up to 2000 teraflops of performance to unify intelligent functions such as automated and assisted driving, parking, driver and occupant monitoring, digital instrument cluster, in-vehicle infotainment (IVI) and rear-seat entertainment.

The superchip comes packed with AI capabilities first introduced in the Nvidia Hopper multi-instance GPU architecture, along with the Grace CPU and Ada Lovelace GPU.

Drive Thor with MIG support for graphics and compute enables IVI and adas to run domain isolation, which allows concurrent time-critical processes to run without interruption.

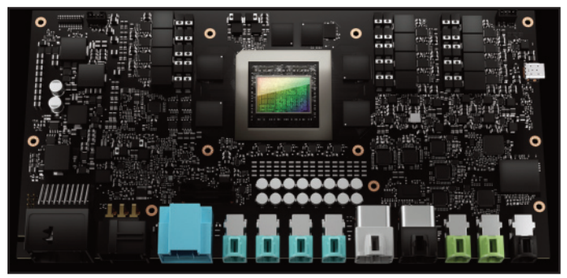
"Advances in accelerated computing and AI are moving at lightspeed," said Jensen Huang, CEO of Nvidia. "Drive Thor is the superhero of centralised compute, with lightning-fast performance to deliver continuously upgradable, safe and secure software-defined supercomputers on wheels."

Geely-owned vehicle maker ZeekR announced it would integrate Drive Thor into its next intelligent electric vehicles, starting production in early 2025.

"ZeekR users demand a luxury experience that includes the latest technology and safety features," said ZeekR CEO An Conghui. "Drive Thor will support our mission of providing cutting-edge technology that fulfils the needs of our customers and ensures ZeekR remains at the forefront of tomorrow's innovations."

Drive Thor supports multi-domain computing, isolating functions for automated driving and IVI. It lets manufacturers consolidate many functions on a single SoC, which eases supply constraints and simplifies vehicle-design development.

It is also the first AV platform to incorporate an inference transformer engine, a component of the Tensor Cores within Nvidia GPUs. With this engine, Drive Thor can accelerate inference performance of transformer deep neural networks by up to nine times.



Drive Thor could be heart of self-driving cars

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IN THIS ISSUE

2: Renesas acquires Steradian for radar

4: Google helps Sibros with V2C

5: How clever will the Volvo EX90 be?

7: STM supports software transition

8: Elektrobit and NXP BMS software

10: Continental combines sensors

13: Report from Aesin conference

19: Optimising TIA lidar interfaces

27: Lidar's role in autonomous driving

29: Wearables transform ecosystem

35: Looking inside the Toyota Rav4

39: Product news

44: Contact details

Renesas acquires Steradian to access adas radar

Renesas is to acquire Steradian Semiconductors, a fabless semiconductor company based in India that provides 4D imaging radar, in an all-cash transaction.

The acquisition is expected to close by the end of this year and should let Renesas extend its reach in the radar market and boost its automotive sensing offerings.

In automotive, radar can accurately detect objects over long distances, day or night, even during harsh weather or other adverse environmental conditions. For these reasons, radar is considered an essential sensing technology for adas, and the number of radar sensors installed in vehicles is expected to triple over the next five years.

To respond to such growth potential, Renesas is expanding its automotive product portfolio with Steradian's radar technology.

"Radar is an indispensable technology for adas, which uses a complex combination of various sensors," said Hidetoshi Shibata, CEO of Renesas. "The addition of Steradian's superb radar technology and engineering talent will allow us to extend our leadership."

Founded in 2016, Steradian has expertise in radar operating in the 76 to 81GHz band. Its 4D radar transceivers offer a high level of integration in a small form factor and high power efficiency.

"By working with the Renesas team, we will continue to develop innovative radar that delivers the high performance, small footprint and low power consumption that our customers desire," said Gireesh Rajendran, CEO of Steradian.

Renesas will leverage Steradian's design assets and expertise to develop automotive radar, with plans to start sample shipments by the end of this year. The firm aims to develop complete automotive radar combining adas SoCs for processing radar signals, power management ICs, and timing products with software for object recognition.

WeRide robo-bus in Saudi Arabia



Chinese autonomous driving company WeRide collaborated with the Saudi Company for Artificial Intelligence (Scai) to launch a driverless robo-bus at September's 2022 Global AI Summit in Riyadh, Saudi Arabia.

This was the first fully driverless test ride of a robo-bus in a Middle East country.

"Riyadh is a city full of innovation, and its smart city ecology is rapidly developing," said Yan Li, CTO of WeRide. "Autonomous driving is an important part of the smart city ecosystem. The launch of WeRide's robobus in Riyadh is a very exciting exploration for both Riyadh and WeRide. Based on the premise of prioritising safety, L4 autonomous driving technology not only improves the efficiency and experience of future urban mobility, but also redefines the travel space. We can envision that the smart city will be connected by different scenes and varied autonomous driving products in the future."

WeRide previously launched the first driverless public robotaxi service in the Middle East in Abu Dhabi.

Autotalks and Cohda partner on V2X SoC



Applications can share sensor data provided by other vehicles

Autotalks and Cohda Wireless collaborated to create an integrated V2X SoC.

Autotalks' Tekton 3 chipset will run Cohda's full V2X software stack. The built-in software will enable tier-ones and OEMs to integrate the V2X device easily, with lower development and testing expenses, while assuring quality and optimisation

Cohda's stack is said to be the first in the world to be deployed in production vehicles and is the only software in two automotive production vehicle platforms.

The Tekton 3 chipset will run Cohda's full V2X software stack.

Tier-ones and OEMs should benefit from having one company, Autotalks, responsible for the entire V2X functionality rather than the responsibility being shared between multiple hardware and software suppliers.

There is no need for any external host or software integration. This increases security as the V2X hardware and software are isolated from non-safety functionalities and wireless links, specifically the cellular modem.

Tekton 3 connects directly to adas, simplifying the fusion of V2X data.

The SoC supports 5G C-V2X day-two use cases. Day-one V2X offers life-saving situational awareness alerts.

Day-two V2X applications can share sensor data provided by other vehicles and enable critical actions such as automatic braking.

"Adding V2X to a vehicle becomes as simple as plug and play," said Hagai Zyss, CEO of Autotalks.

Cohda Wireless CEO Paul Gray added: "Our collaboration with Autotalks is a significant milestone and takes our industry another step forward to the widespread adoption of connected, intelligent transport systems."

T-Systems joins Eclipse on software-defined vehicles

T-Systems has joined the Eclipse Foundation to work on open-source software for the automotive industry in its software-defined vehicle working group.

The company is involved in the development of core functions and standard technologies for the digitally connected vehicle. Other members of the working group include Bosch, Continental, ZF, Microsoft, Red Hat and Volkswagen subsidiary Cariad.

T-Systems will bring its expertise in software, connectivity, cloud and embedded systems to the working group.

The company combines different technologies in open-source projects for the automotive industry to enable the most seamless and rapid development of software.

"The software-defined vehicle is not a task for individual companies or technology areas, but a challenge for the entire automotive industry," said Christian Hort, responsible for the automotive business at T-Systems. "The open-source approach is primarily intended to combine the forces of all participants and thus accelerate the development of software and the toolchain."

He said it was fundamentally important that all stakeholders shared valuable assets and that the developer community worked together productively.

"Competitive situations must not slow down this process," he said. "Only in this way will the speed of development and the desired leaps in innovation really come about."

Mike Milinkovich, executive director of the Eclipse Foundation, added: "The main vision of Eclipse's software-defined vehicle is to provide a unified open-source platform for the automotive industry using our code-first approach."

Google helps Sibros with vehicle-to-cloud options

Connected vehicle platform company Sibros has partnered Google Cloud to bring flexible and intelligent connected vehicle-to-cloud options to automakers worldwide.

Sibros' deep connected platform is for full vehicle over-the-air software and data management that meets industry safety, security and data privacy requirements.

Sibros' automotive software and data management platform is an integrated suite of embedded software, telematics, network stacks and SaaS applications, which includes the deep connected platform. It will use Google Cloud's scalable infrastructure with data analytics, visualisation, AI, machine learning and API management tools.

Hemant Sikaria, Sibros CEO, said: "This partnership is a big leap in our mission to deliver safe and secure connected automotive technologies."

Sibros' connected vehicle offering will be available on Google Cloud with a variety of Google apps, cloud and automotive services to help automakers reinvent the connected mobility experience with remote vehicle services and mobile apps, real-time fleet data and edge analytics, remote diagnostics and preventative maintenance, and full vehicle over-the-air software updates.

The hardware agnostic offering connects cars, lorries, buses, scooters, e-bikes and tractors to Google Cloud, giving automakers a single source of truth, visibility and governance over all software and data across globally connected fleets. It can be deployed on in-vehicle operating systems, including Android Automotive.

The combination carries ISO 26262 certification with an Asil-D rating for automotive OTA software updates.

"Google Cloud is committed to helping automakers reimagine the connected vehicle experience," said Matthias Breunig, automotive director at Google Cloud. "Sibros has built a distinctive platform to manage fleets of globally connected vehicles based on modern connected vehicle architectures, embedded software and Google Cloud technologies."



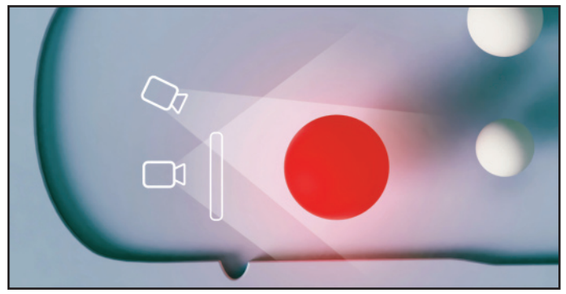
Volvo's EX90 knows when drivers are not at their best

Volvo's driver understanding system will be standard in the EX90 car due to be revealed in November.

This real-time interior sensing system means the car can understand when the driver is in a state that isn't optimal for driving and make sure action is taken to avoid accidents.

"Our research shows that by simply observing where the driver is looking and how often and for how long their eyes are closed, we can tell a lot about the state of the driver," said Emma Tivesten, senior technical expert at Volvo Cars' safety centre. "By basing its calculations on our research findings, the sensing system allows our cars to identify whether the driver's ability is impaired, perhaps due to drowsiness, distraction or other causes for inattention, and to offer extra assistance in a way that best suits the situation."

Using two cameras to observe the driver's eye-gaze patterns, it can pick up early signals that indicate the driver is not at their best. By measuring how much of the time the driver looks at the road ahead, allowing for natural variations, it understands when the driver's eyes, and perhaps therefore mind, are focused somewhere other than on driving.



Two cameras monitor the driver

Is the driver looking at the road too little? It can be a sign that they are visually distracted, perhaps from looking at their phone. Too much? That can be a sign of cognitive distraction, which could mean the driver is occupied by their thoughts to the point where they no longer register what they are looking at.

The car's capacitive steering wheel also plays a role. It senses if the driver lets go of the wheel, thus monitoring the stability of their steering input.

By using patented technology for real-time sensing of gaze patterns and steering behaviour, the car will be able to take appropriate action to help the driver when needed. The assistance can start with a simple warning signal that grows in volume with the severity of the situation. If the driver doesn't respond to increasingly clear warnings, the car can even safely stop by the side of the road, sending a warning to other road users with its hazard lights.

"We've made great progress on exterior sensing in the past decades, thanks to our committed work on crash prevention systems," said Thomas Broberg, acting head of Volvo Cars' safety centre. "Interior sensing is one of the next safety frontiers for us. We will continue to learn, develop and deploy new features step by step to help improve safety as our knowledge increases and matures."

For the exterior, the EX90 will have eight cameras, five radars, 16 ultrasonic sensors and a lidar sensor.

Embedded in the roofline, the lidar can detect pedestrians at up to 250m and something as small and dark as a tyre on a black road 120m ahead while traveling at highway speeds.

Tasking acquires iSystem to enhance safety software

Tasking has acquired iSystem, a provider of software tools supporting embedded software development and testing.

ISystem manufactures embedded software development tools ranging from simple debuggers to software analysis tools. It was founded in 1986 and was previously privately owned with more than 80 employees distributed over five locations in Europe and the USA.

The addition of iSystem enhances Tasking's safety and security software ecosystem and broadens its capabilities in embedded software development tools and services with an emphasis on the automotive safety market.

ISystem's debugger and software trace and analysis tools complement Tasking's functionally safe embedded software development tools.

The combination of technology and software know-how should allow Tasking to continue as a tool provider for applications such as adas, automated driving and vehicle electrification.

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STM supports transition to software-defined vehicles

ST Microelectronics is supporting the transition to software-defined vehicles with its latest MCUs. They are also the first to integrate the Can-Xl in-car communications standard to support electric vehicles.

The company's Stellar P automotive MCUs are targeting model year 2024 vehicles for electrified drivetrains and domain-oriented, over-the-air updateable systems.

This technology lets vehicle platforms handle growing data flows so the car can operate at peak performance.

"The real-time, power-efficient Stellar P6 automotive microcontrollers combine advanced integration of motion-control and energy-management domains with actuation capabilities, ensuring a smooth shift from traditional ICEs and EVs to new drive-traction architectural patterns of software-defined vehicles," said Luca Rodeschini, vice president at ST Microelectronics.

Car makers are transitioning to software-defined vehicles to manage the complexity and performance of the features they are adding to vehicles such as electrification, safety, and assisted and automated driving. This transition requires top to bottom revamping of the car's architecture.

Changes include moving from many ECUs that each manage a small subsystem to domain or zone controllers that combine multiple functions. These controllers must also manage the consolidation of software from across a range of vehicle systems.

In software-defined vehicles fully driven by electronics systems, Stellar delivers synchronised operations and secure over-the-air software upgrades of all systems for both maintenance and continued performance improvement.

Manufactured in STM's wafer fabs using 28nm FD-SoI technology, the P6 embeds up to 20Mbyte of phase change (non-volatile) memory (PCM). Developed and tested for high-temperature operation, radiation hardening and data retention, PCM also delivers faster access time through single-bit overwrite, a feature unavailable in flash.

Over-the-air updates with no downtime leverage a mechanism that saves memory by dynamically allocating memory space to the new downloaded software image until it is validated. This happens while the rest of the memory continues to execute the running application in real time.

The Stellar P6 MCUs contain up to six Arm Cortex-R52 cores, some operating in lockstep and some in split-lock mode for failsafe redundancy.

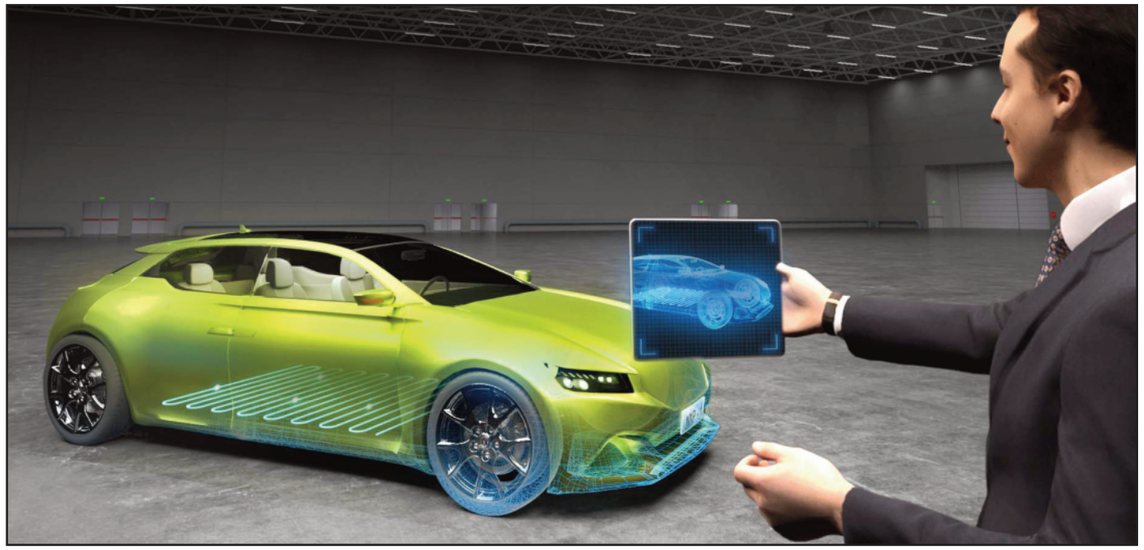
They manage hardware virtualisation (sandboxing) using the Cortex-R52 features and firewalls to resource access. This simplifies the development and integration of multiple-source software on the same chip while ensuring safe isolation and performance.

Safety measures at all levels of the architecture ensure efficient implementation of ISO 26262 Asil-D functions. In addition, the FD-SoI technology inherently offers a quasi-immunity to radiation and protects against system unavailability while ensuring compliance with stringent safety standards.

• AI company Smart Eye and STM are jointly developing a high-sensitivity, one-LED driver monitoring system combining Smart Eye's expertise in driver monitoring algorithms and optical design with STM's VB56G4A global-shutter imager.



Qualifiable Stellar MCUs support transition to software-defined vehicles



Elektrobit and NXP develop BMS software

NXP is collaborating with Elektrobit to develop software for automotive battery management systems (BMSs).

The jointly developed software aims to reduce the entry-level cost of BMS development and enhance ease-of-use of NXP's high-voltage BMS reference design.

Using Elektrobit's Autosar Classic tooling and software, the platform can ease the development of BMS architectures for EVs by abstracting the communication and controlling interactions between the BMS microcontroller and the battery cell controllers.

As demand for EVs continues to increase, so does the demand for improved performance, faster charging time, increased range and battery life, and improved safety. These demands drive rapid technological advancements in EV battery designs, especially for 400 or 800V systems.

As these batteries become more powerful and complex, more sophisticated BMS architectures are needed to ensure safety and reliability.

The reference design is a scalable Asil-D architecture with three modules: battery management unit, cell monitoring unit and battery junction box.

NXP's portfolio of battery cell controllers, battery junction box devices and devices for its electrical transport protocol link, along with production grade software drivers for these silicon devices, makes it easier for OEMs and tier-one suppliers to enter the growing high-voltage BMS market and lets them focus effort on their application features.

Elektrobit has been collaborating with NXP for more than ten years. Using Elektrobit's EB Tresos, NXP's reference application software and complex device drivers are integrated into the reference design.

"Our EB Tresos AutoCore is the implementation of the Classic Autosar standard and our EB Tresos Studio tooling environment configures these basic software modules with NXP's software modules," said Michael Robertson, Elektrobit VP. "Elektrobit will additionally offer support to customers that use NXPs high-voltage BMS platform when configuring and integrating EB Tresos AutoCore into their environment, and will continue working with NXP in the second development phase of the reference design software."

NXP director Andreas Schlapka added: "NXP and Elektrobit have complementary competencies. NXP has extensive knowledge in BMS, with a scalable portfolio of analogue and digital silicon devices to support the full variety of BMS architectures. Elektrobit has in-depth knowledge of the software architectures that are used in the automotive domain and Autosar expertise. Bringing these two competencies together is key, which is why NXP selected Elektrobit to join forces to co-develop the software platform for the reference design."

Harman Ready to help drivers

Samsung subsidiary Harman has launched Ready Care, combining machine-learning algorithms with vehicle sensors to monitor a driver's physical behaviour and actively intervene.

Ready Care has options covering cognitive distraction, stress-free routing and personalised comfort that can work together or independently to improve safety and reduce driver stress.

It measures cognitive load for drivers in real time, responding with tailored interventions to instances of distraction, drowsiness or anxiety.

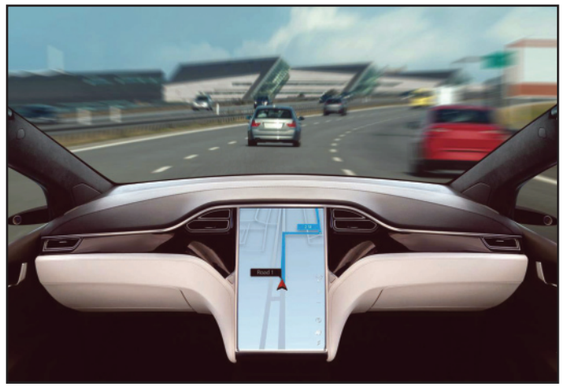
Rooted in safety, Ready Care offers OEMs a platform to deliver progressive security, routing and comfort measures to drivers. The experience is powered by machine-learning algorithms that gather and process data from in-vehicle cameras and sensors to monitor a driver's state and generate customised in-vehicle cabin prompts to trigger a range of behavioural responses increasing awareness, alleviating stress or inducing or stimulating ease and relief.

"Safety remains a top concern for consumers when considering a new vehicle purchase and, now, with Ready Care, OEMs can improve vehicle safety in a significant new way," said Armin Prommersberger, senior vice president at Harman. "Ready Care is essentially a co-pilot, spotting when distractions could turn into dangerous situations and intervening to avoid them. For the first time, the vehicle can know what the driver is thinking; this is a game changer."

It measures both driver eye activity and state of mind.



Ready Care eases burden on drivers



U-Blox expands GNSS service in South Korea

U-Blox has expanded its PointPerfect GNSS augmentation service to South Korea.

The PPP-RTK (precise point positioning, real-time kinematic) high precision positioning lets various applications be officially commercialised in the country.

The service is accessible via Thingstream, the firm's IoT service delivery platform, an enterprise-grade cloud interface that can support billions of messages.

PointPerfect delivers a GNSS augmentation data service designed to be accurate, reliable and immediately available. The service enables the demand for high precision GNSS in autonomous vehicles such as unmanned aerial vehicles (UAV), service robots, machinery automation, micro mobility and other navigation applications.

Emerging automotive applications that can also benefit from the service include automated driving and adas, lane-accurate navigation, and telematics.

"By bringing U-Box PointPerfect GNSS augmentation service to South Korea, we are taking an important step in Asia towards achieving our objective of globalising our mass-market-focused service," said Franco de Lorenzo, principal product owner at U-Blox. "It is the first PPP-RTK service commercialised in South Korea and can lower barriers to adoption and support scaled-up high precision positioning by reducing time to market."

For example, automotive manufacturers in South Korea can now advance their automated driving applications in-country for use in South Korea as well as in the USA and Europe.

Continental combines commercial vehicle sensors

Continental presented an innovative sensor option for commercial vehicles at September's IAA Transportation event in Hanover.

The multi-sensor system, known as the Continental Sensor Array, can be mounted above the windshield.

It targets the growing number of intelligent and automated driving systems in commercial vehicles. Furthermore, higher levels of automation such as level-four require a larger number of different sensors that can be installed intelligently, quickly and safely.

In this offering, all integrated sensors – lidar, radar and cameras – for adaptive cruise control, emergency braking and blind spot assist as well as automated driving functions are pre-calibrated and coordinated with each other.

This simplifies the installation of many sensors, their integration into the vehicle architecture and the complex process of calibration.

In addition, the effort for maintenance and thus the downtimes of vehicles are reduced.

As an expert in radar, lidar and cameras for assisted and automated driving, Continental sees the intelligent combination of these different technologies as a decisive added value in terms of safety.

"With the Continental Sensor Array, we are demonstrating a tailor-made system approach for commercial vehicles," said Claudia Fründt from Continental. "We see great potential in automated and ultimately autonomous driving in the commercial vehicle sector, especially in view of the high number of downtimes. Highly complex sensor systems are necessary for essential, holistic environment perception."

With the multi-sensor system, Continental offers everything from a single source when it comes to safety-relevant sensor technology including sensors, central computing units for control, calibration of the individual sensors among each other, and calibration of the overall system when mounted on the vehicle.

"A compact multi-sensor system offers vehicle manufacturers and users many advantages," said Andree Hohm from Continental. "Radar, lidar and cameras are pre-calibrated and matched to each other. The effort for the final calibration of the sensor during assembly, the effort for the assembly of the sensor systems themselves and, finally, for the maintenance of the vehicles are significantly reduced."

When trucks drive autonomously and are on the road around the clock, the sensor array can be replaced for maintenance work, for example. In this way, costly downtimes can be avoided.

In addition, the electronic architecture and wiring harness in commercial vehicles can be streamlined and later updates implemented quickly. Sensors for new assistance systems can be integrated.

The overall sensor system does not require any fundamental modifications to the driver's cab or vehicle body for future generations of lorries. It can also be mounted on existing modern trucks, provided the on-board electrical system is prepared.

Cleaning and air conditioning of the sensor units are also simplified. Continental has an automatic camera and sensor cleaning, cooling and heating system in its portfolio.

All sensors independently monitor the degree of their pollution. Camera lenses are automatically cleaned by water jet. In addition, intelligent thermal management ensures the flawless use of sensor technology in all weather conditions.

Continental sees the joint use of the three sensor systems as ideal for reliable recognition of objects and holistic detection of the vehicle's surroundings.



Continental presented modular multi-sensor option for commercial vehicles

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Arcturus and Kinara optimise smart city AI

Edge technology firm Kinara has partnered Arcturus Networks to help deliver AI for smart-city applications such as real-time road condition monitoring.

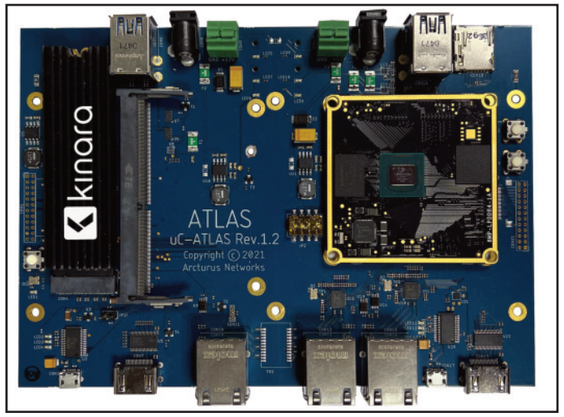
This can, for example, let public transport buses retrofitted with smart cameras detect road obstructions such as potholes and report them directly to city operations.

The partnership combines the Kinara Ara-1 edge AI processor with Arcturus Brinq edge AI and vision analytics software to drive detection, tracking and characterisation applications.

The Ara-1 Edge AI processor delivers a combination of performance, power and price for integrated cameras and edge servers. The Kinara architecture can run multiple models with low latency and zero switching overhead, generating results faster and more accurately.

Kinara complements its processing technology with development tools with built-in quantiser, simulator, profiler and compiler to help its users optimise and run their neural network models using the Ara-1 processor.

Brinq is edge AI software that combines vision algorithms, inference, analytics applications and tools to help fine-tune machine-learning models. The software includes multiple object tracking technology.



Arcturus Atlas platform using NXP i.MX 8M Plus SoC and Kinara's Ara-1

Supported hardware includes the Arcturus Atlas scalable edge inference platform using NXP's i.MX 8M Plus SoC and accelerated using Kinara's Ara-1.

"Our Brinq software provides a flexible edge AI pipeline architecture that makes it easy to integrate a variety of compute units such as CPUs, GPUs or NPUs," said David Steele, director of innovation at Arcturus Networks. "By using Kinara's Ara-1 processor, we can deliver more sophisticated smart city analytics that achieve higher throughput and improved accuracy. This allows us to enable a new generation of edge AI applications while achieving excellent price-performance value for our customers."

Markus Levy, vice president at Kinara, added: "Arcturus uses its Atlas platform with NXP's i.MX 8M Plus applications processor to provide excellent in-device inference performance for standard classification and detection algorithms, and we can cost-effectively add our Ara-1 edge AI accelerator to the Atlas platform to deliver the ability to scale up to an additional twenty times higher inference performance for more complex models and applications demanding higher resolution and higher accuracy video processing.

And Ali Osman Ors, director at NXP, said: "It's great to see our partners, Arcturus and Kinara, working together to add significant value to the NXP ecosystem. Their collaboration will help to extend the benefits of products like the i.MX 8M Plus and provide our mutual customers further scalability in developing real-world AI."

Allegro completes Heyday acquisition

Allegro Microsystems has completed its previously-announced acquisition of Heyday Integrated Circuits.

Heyday is a privately held company specialising in compact, integrated isolated gate drivers that enable energy conversion in high-voltage gallium nitride (GaN) and silicon carbide (SiC) wide-bandgap designs.

This acquisition brings together Heyday's isolated gate drivers and Allegro's isolated current sensors to enable smaller high-voltage and efficient power systems.

The acquisition is expected to increase Allegro's addressable market for electric vehicles, solar inverters, data centres, 5G power supplies and industrial applications.

AESIN
AUTOMOTIVE ELECTRONICS INNOVATION

WHO ARE THE CHAMPIONS?



Martin Wilson reports from September's Aesin conference near Birmingham, UK

The overall theme of this year's Aesin conference was championing the champions. It sought to explore how the UK automotive electronics industry could continue to drive technological innovation through knowledge sharing and leadership.

Jennie Martin of ITS UK, the opening keynote speaker, highlighted the importance of winning public opinion through demonstrating social benefits of technical revolutions, such as the London congestion charge; the need to gain public trust in technology was also raised by other speakers.

Similarly, the skills shortage was something of a drumbeat during the day. Martin made the point with a strong line on the importance of diversity in the workforce, with the argument that the evidence showed diversity supported performance. She



Darren Capes: Stop cars running into people



Jennie Martin: Diversity in the workforce is important

stressed lip service was not enough, that it was everyone's responsibility – "If it is wrong call it" – don't collude.

Darren Capes from the Department of Transport raised the growing importance of interconnection between infrastructure and vehicles as a means of continuing to improve road safety now that benefits from infrastructure improvements were essentially flat. Even though fully autonomous vehicles are still some way off, there is the need for producer road maps to harness that growing capability and infrastructure-vehicle connectivity to stop "cars running into people".

The rapidly growing complexity of automotive software makes testing and validation critical. Lee Harrison, automotive IC manager at Siemens, made the point that over-the-air updates had to address the challenges of testability, maintaining safety and security.

A key point was with building confidence in autonomous driving for example "being able to prove some of this technology in simulation really helps build the confidence in the technology". He suggested that Siemen's Xcelerator programme closes the loop, reflecting the importance of validating data and software. Similarly, Phil Clarke of DSpace argued for the importance of using hardware-based emulators for development and testing as it could not all be done using vehicles and software emulation had limits.

Raj Kumar Sahu, associate architect at KPit, backed up the argument suggesting a homologation-based approach to meet regulatory need efficiently for "extensive verification and validation coverage".

In the same vein, development and testing methods came under scrutiny with Geoffroy Heurtier, project engineer at Claytex, stressing the need to think through the validation paradigm with regard to the problem entity, conceptual model and computerised model.



Geoffroy Heurtier: Think through the validation paradigm

Clark raised the question of having sufficient data to test comprehensively.

Marcus Nissemark, field applications engineer at Green Hills Software, backed that up and demonstrated the value of effective "instrumentation" of software under test to collect data and, with the high volumes of data produced, stressed the need for tools to allow visualisation of software behaviour to allow verification and optimisation, especially with regard to the performance of real-time systems.

Both Francesco Petruzzielo of ST Microelectronics and Robert Moran of NXP emphasised that the automotive megatrends –



Lee Harrison: Over-the-air updates had to be secure



Francesco Petruzzielo: Time to reinvent the wheel

autonomous driving, connectivity, electrification and software-defined vehicles – were continuing to accelerate. Petruzzielo made the point that it was "time to reinvent the wheel, to increase the value of the car over its lifetime".

They both saw new business models coming from software-enabled services being offered as well as allowing improved optimisation of operation and maintenance through software updates during the life of a vehicle. There was agreement that new system architectures for vehicles were going to be needed to support the growing capability and complexity.

The existing distributed networks by function were challenged by an expected need for a tenfold increase in computation power. The intermediate domain model with the aggregation of processing power by function would be short-lived or even bypassed in favour of zone-based architectures with greater centralisation of processing using fewer processors, such as the Arm-based Stellar Integration MCU.

Moran highlighted how this model decoupled hardware and software lifecycles using a service-oriented architecture that supported continuous integration and deployment with standardised automotive frameworks. This fits with Petruzzielo's vision of cars being a platform for software that provides business opportunities from increasing AI and smart functionality during the life of the vehicle.

Many speakers suggested data and connectivity were key challenges for software-defined vehicles (SDVs) and security was therefore an issue. The car has to remain safe even when being updated over the air.

Alan Platt, CEO of Cyberhive, proposed a major risk to connectivity was the possibility of generally available quantum computers in the next few years. He argued that quantum computers would be available to break current encryption methods in under an hour rather than the decades, or centuries, needed by current computers.

Cyberhive is ready with a robust offering using existing zero-trust networking techniques that provide digital security by design.

Rob Potter, CTO of Bean Connectivity, also made the point that connection would be key to the SDV and provided challenges for balancing connection speed and usability with the need for security. He described ways both



Robert Moran: Automotive megatrends continue to accelerate



Neil Dickins: Electronics engineering skills see minimal growth

connection performance and security of data could be measured to inform decisions around market positioning and time criticality of connections to support their idea of the connected vehicle as a service (CVaaS).

The panel discussion focussed on the topical issue of creating and managing supply chains. Several key points were raised including that the need for sovereign, local capability in the UK was critical, especially around electrification. It was suggested that the UK had strong networks and expertise but government lacked understanding of the importance of semiconductors so there was a need for a "once in a generation" dialogue to address the problem.

There was agreement that the UK was not going to be self-sufficient in components needed for autonomy, even though it was for the traditional bill of materials for vehicles. Therefore, the automotive industry needed to focus on the opportunity to build supply chains targeting resilience rather than price or volume.

The automotive sector is a driving force on power control, autonomy and sensor technology, which makes it well placed to use its knowledge and its supply chains to enable migration into other sectors, and to leverage that experience in the wider UK economy.

A big issue is the need for timely data to allow a dynamic response to supply chain volatility. The traditional approach will no longer work; there is the need to be more agile.

A consistent issue was the need to address the shortage of staff with the skills needed for today's automotive engineering sector. As Neil Dickins of Intellectual Capital Resources explained, there had been a 25% salary inflation for such roles in the last year but the availability of electronics engineering skills had seen minimal growth.

In closing the conference, Alan Banks, CEO of TechWorks, reiterated that the pace of change had accelerated out of all recognition in the past five years. In particular, it included the convergence of technologies especially around security, connection, autonomy and software. This was creating challenges for companies, with the supply chain and the shortage of suitably skilled engineers and other staff being inhibiting issues.

Consequently, TechWorks was in the process of creating workstreams to encourage and enable its members to work together to respond to the challenge.



Alan Banks: Convergence of technologies

LIDAR



Noe Quintero and Tony Pirc explain how to design and optimise the TIA interfaces of lidar systems

NOT TO BE OVERLOOKED

The effects of various input coupling options for transimpedance amplifiers (TIAs) can have easily overlooked consequences, but engineers can effectively design and optimise the TIA interfaces of a lidar system.

Lidar input is not a trivial topic, and there are going to be many moving parts in this process. The signal chain is going to be different depending on which design is chosen, so it's important to consider all the options before picking the one that is best for a project.

Time-of-flight lidar receiver signal chains have a slew of design trade-offs that can potentially compromise the performance of an imaging system. The interface between the TIA and its detector is part of this challenge. This is especially true for transimpedance amplifiers with multichannel switching.

Building blocks

A time-of-flight lidar is composed of a transmitting signal chain and a receiving signal chain. The transmitting portion sends a pulse of photons at an object, and the receiving portion measures the amplitude and nature of that pulse.

The amount of time it takes for the light to travel from transmission to detection shows how far the light has travelled.

At the most fundamental level, the receiving signal chain consists of a photodetector, a TIA and an analogue-to-digital converter (ADC), as seen in Fig. 1.

For multichannel applications, a multiplexer is used to reduce the number of ADCs. When photons strike the photodetector, it generates a current that is converted to a voltage by the TIA. This voltage is then quantised to a digital value by an ADC.

Another popular choice for a quantiser is with a comparator and time-to-digits converter (TDC), as shown in Fig. 2. These TDC systems have an order of magnitude less cost and power while trading off lower system performance. Also, the use of a multiplexer is typically not used with TDC but can be implemented to reduce the number of TDCs and comparators.

There are three dominant types of detector. Photodiodes are detectors that convert photons to electrons, but offer no optical gain and are not a popular choice for these applications. A popular

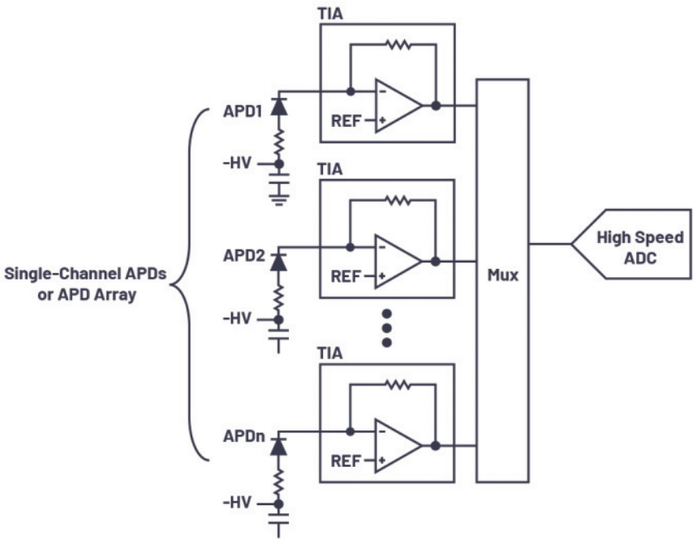


Fig. 1: Lidar receiver signal chain quantised by an ADC

detector in lidar is the avalanche photodiode (APD). APDs are photodiodes that are reverse biased up to breakdown of the junctions with the benefit of gaining optical gain.

The third type of detectors are single photon avalanche diodes (spads). A spad is reverse biased with an excess bias voltage that is between the breakdown voltage and the second, higher breakdown voltage associated with the spad's guard ring.

At this bias, a single charge carrier injected into the depletion layer can trigger a self-sustaining avalanche, resulting in thousands of virtual gain at the detector. It would seem the spads would be the natural choice due to their sensitivity. However, lidar must contend with many real-world consequences and too much gain will saturate the receive chain too easily. Also, the extra gain comes with extra noise, called the excessive noise factor (ENF).

The ENF is exponentially correlated to the bias, and too much gain can give a worse signal-to-noise ratio (SNR) to the detector. Luckily, APDs are a happy medium, offering enough optical gain for this space, but not too much ENF to impact the SNR negatively.

When a photon strikes the APD, an electron hole pair is created at the junction. The APD's high electric field acts like a slingshot and accelerates the electron to knock off more electrons. This increases the number of released electrons per received photon. This effect is called the avalanche effect and it adds a multiplication factor (M factor).

This gain, which is bias dependent, can let weaker signals be seen since the TIAs are generally the limiting factor for SNR due to its noise floor. The goal is to match the noise floor of the next stage in the signal chain. In this case, match the TIA's noise floor by providing enough gain in the APD to dominate the signal chain noise slightly to give the best SNR to the system.

This noise matching concept is widely used in many signal chains where the sensor noise floor is not the limiting factor. In practice, this increase in receiver performance translates to an extended detection range.

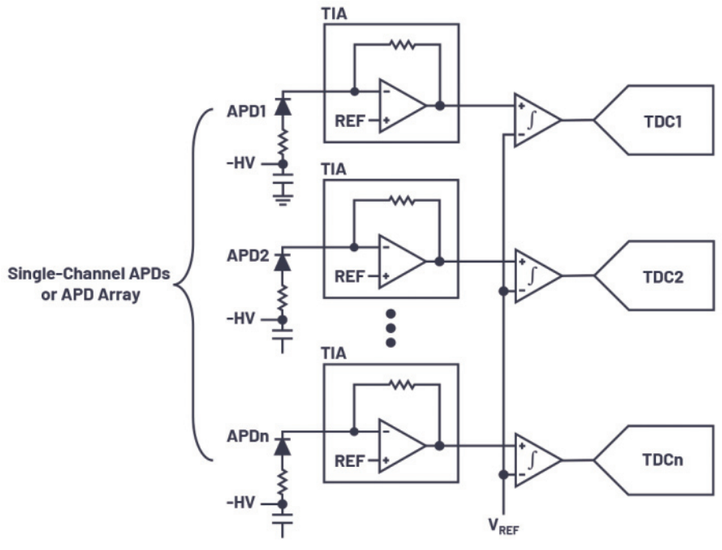


Fig. 2: Lidar receiver signal chain quantised by a TDC

Another important advantage of APDs is a fast saturation recovery. Again, the TIA is the limiting factor in this and lidar specific TIAs are designed to reduce the saturation times to avoid blinding the lidar. The only downside of APDs is their relatively high bias point (hundreds of volts) and the associated temperature coefficient.

Lidar has unique requirements for TIAs. Low current noise and high bandwidths are typical for all optics applications. However, low power is a necessity. A system's power budget may come under strain very quickly since current systems have 64 or more TIA APD channels. As such, lower power modes are necessary when the TIA is not in use.

Also, these devices need to wake up quickly to optimise their power budget.

Another requirement for modern lidar TIAs is clamping circuits for saturation events and to balance and trade-off input referred noise and bandwidths. One major difference between the normal optical signal chain and lidar is the environment. In fibre applications, the system is enclosed and is very stable. However, in lidar the sun has to be considered, as well as other lidar systems. The sun could cause a DC input that saturates the receive chain linear range. This is one of the first challenges engineers must overcome when designing these systems. Unfortunately, this is not easy.

Considerations

A simple approach to block the DC signal is one that many engineers try to implement without much success: connecting an AC-coupling capacitor between the APD to the TIA. By placing a capacitor, DC effects can be mitigated, but this introduces a new set of challenges.

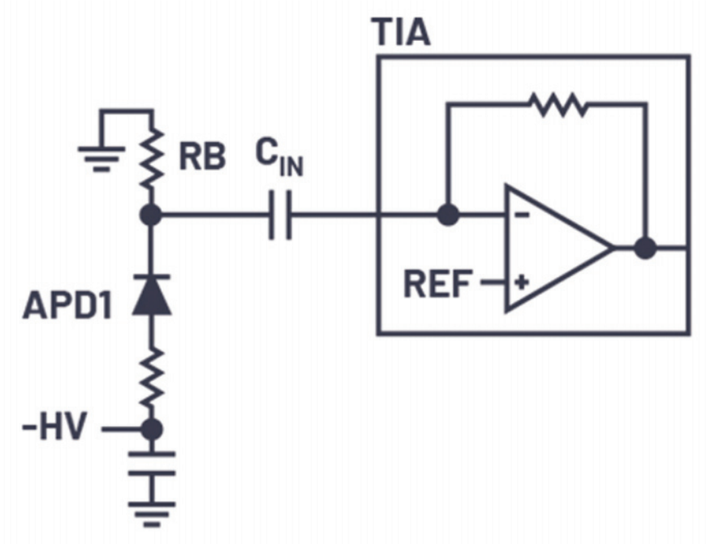


Fig. 3: RB is needed to AC couple the TIA

RC trade-offs

First, adding an AC-coupling capacitor to the input of the TIA input also requires connecting a DC path to the detector. By placing a resistor, RB, the APD's bias point can be set to AC couple the TIA input with C_{IN}, as shown in Fig. 3.

One sacrifice with this bias path is it creates a parallel path for the APD current to flow through. This parallel path will negatively impact the gain of the APD since its signal will be shared. The magnitude of this APD gain degradation is determined by the ratio between the TIA input impedance and the value chosen for RB.

Additionally, C_{IN} has an impact on the circuit. When the input is subjected to currents from the APD, a voltage is produced on the capacitor. This effect is due to the integrating current nature of capacitors, where the voltage is a function of current over time and capacitance value.

The goal is to make C_{IN} small enough to reduce charging effects but large enough to allow it to have low enough impedance to pass signals at the frequency of interest. In other words, if C_{IN} is too large, then it takes longer to discharge, but if C_{IN} is too small, some of the signal will be lost as a voltage drop across it, or distortion if the pulses have a long relative timescale to the capacitance.

Any of these effects will severely compromise the signal chain.

Sizing

Sizing C_{IN} too small hurts the full-scale measurement: at 200MHz, a 33pF capacitor looks like 24Ω, which creates a voltage

divider with R_{IN}, usually on the order of a few hundreds of ohms for lidar TIAs, taking 10% off the signal's actual value.

A 10% hit to the signal can easily wipe out the hard engineering work done to optimise other areas such as the optics design.

The pitfall with this AC-coupling approach to cancel DC becomes clear when sizing RB. RB should be large in comparison with the TIA input impedance to prevent gain degradation, but small enough not to compromise the saturation recovery. An impossible balance of choosing RC time constants is compounded by the fact that the input signal of the detector is unipolar.

The square wave nature of the input pulse is averaged on this RC and will remove the TIA's dynamic range. Additionally, the TIA can potentially charge C_{IN} when channel switching or by using output multiplexing.

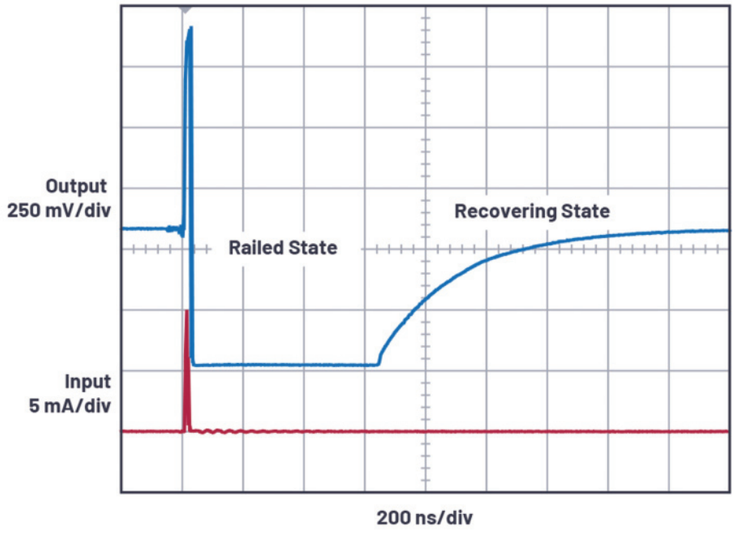


Fig. 5: High input current saturation with C_{IN} = 100pF, RB = 2.2kΩ

For example, with a four-channel multiplexed TIA, the input of the TIA of an active channel is nominally 1.5V. When the channel is inactive, the voltage of the input drops to 0.9V. When an AC-coupling capacitor is inserted in between the detector and the TIA's input, the capacitor must recharge back to 1.5V for the channel to become active again.

Fig. 4 illustrates a multichannel system performance degradation of channel switching versus input coupling capacitor. Note that output multiplexing time (omux) is affected similarly to channel switching since internally it disables the input in the same manner.

The recharging time will be compounded by the first stage RT resistor, which is usually on the order of tens of kilo-ohms since the control loop is broken in this situation. A similar effect occurs in TIAs that shutdown the input stage in shutdown mode to save on power. The inputs must also be recharged to their operating points and will have long time constants to power up.

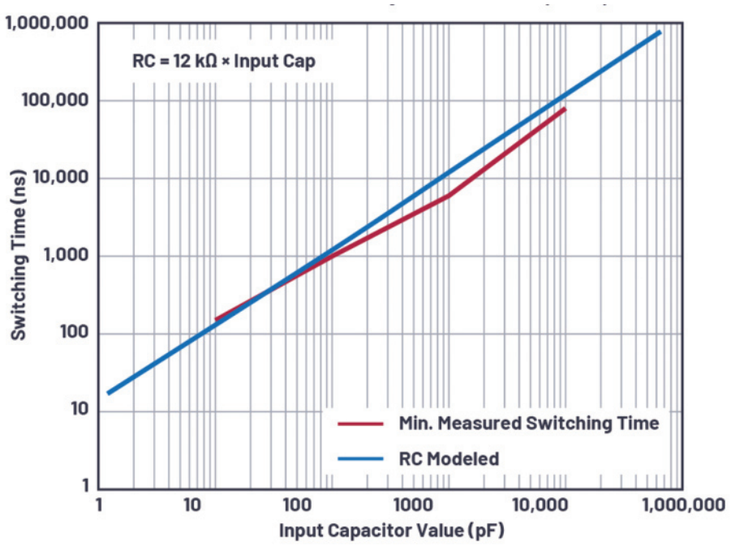


Fig. 4. Plot of omux and channel switching time due to AC-coupled input; RB = 12kΩ

Saturation

Digging deeper in this hole, saturation recovery will be the final nail in the coffin. Fig. 5 shows the output when C_{IN} is exposed to high input currents. The effect of a 10mA pulse to an AC-coupled TIA, where RB is 2.2kΩ, and C_{IN} is 100pF, clearly shows two different regions of operation after the high current pulsed event. After a 10mA input pulse of 5ns, the AC capacitor has been heavily charged and the output of the TIA's output rails to ground.

This output saturation to the ground is a symptom of the input being pulled far from its nominal 1.5V and is a function of the detector's current magnitude and duration. The higher the pulsed current, the longer the output is saturated, pulling to ground.

The second region of operation is the recovering state. This recovery state time constant is correlated to RB and C_{IN}.

Figs. 6a and 6b show the two mechanisms under different conditions and they provide more visual insights. The total recovery time is the sum of the railed and recovery times for the AC-coupled input TIA.

It may be tempting to use a small resistor value for RB to reduce the recovery time, but remember that RB is also a parallel path for the detector and steals some of the input currents; this stolen current translates to the reduction of the overall gain of the APD.

Unfortunately, since lidar is expected to run in the real world, it is possible to see large pulses of light from other systems and cause tens of microseconds of saturation recovery from nanosecond laser pulses.

DC coupling

A DC-coupled input is straightforward. At a high level, the DC-coupled input shown in Fig. 7 allows the TIA to recover quickly from saturation and is limited only by the TIA's saturation recovery.

The disadvantage of this approach is that it will allow DC to pass from the APD to the TIA input. Unfortunately, ambient light, dark currents and leakage caused by the detector can use some or most of the TIA's input linear range.

This reduced dynamic range essentially reduces the receive chains SNR. With enough ambient light, the TIA's dynamic range is severely reduced to zero dynamic range, blinding the system.

The most commonly used methods to reduce ambient light often involve optical filtering, such as that shown in Fig. 8, or the use of active circuits to remove the offset shown in Fig. 9.

Optical band-pass filters can be coated directly on the APD window or on the lens. On a high level, optical band-pass filters will reduce the effects of ambient light.

The optical filter does not help with reflections from the internal optics, which can cause a large, unwanted signal. However, it is a good first line of defence.

An active DC cancellation circuit injects an opposite current into the input of the TIA to counteract the input DC components. This scheme requires a closed loop from the TIA output to its input and great care is needed to preserve the noise and

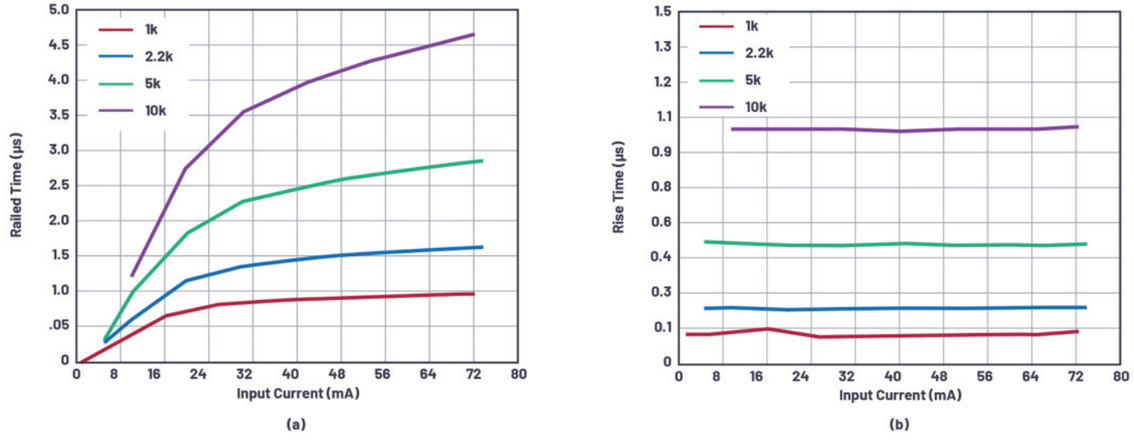


Fig. 6: (a) Railed time recovery for various RB values; (b) Recovering rise-time recovery for various RB values

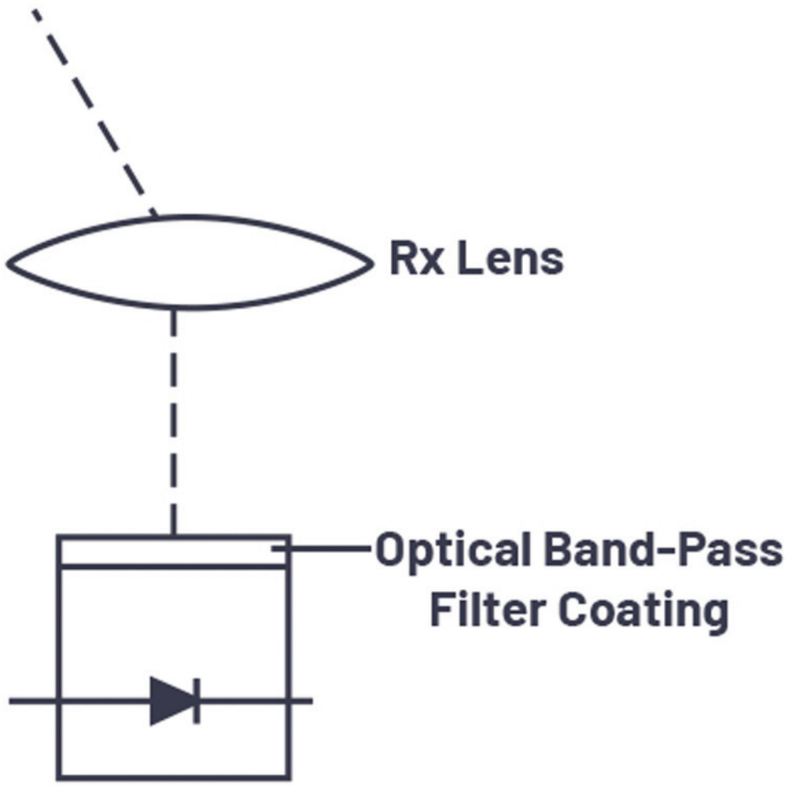


Fig. 7: DC-coupled TIA input

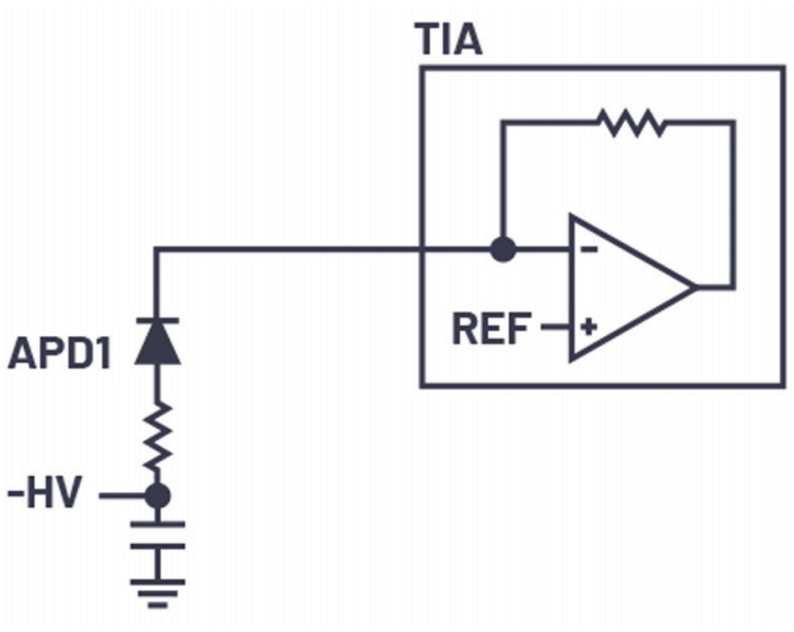


Fig. 8: Optical band-pass filter for removing most ambient light

the switching performance of the TIA.

With TIA gains of 10k to 100k, loop stability is also challenging.

The big takeaway here is once the stability and input capacitance are mitigated in the circuit, the DC cancellation gives the best performance for saturation recovery. However, this comes at the price of added cost and complexity.

Recovery

There are many trade-offs when considering AC versus DC coupling or current cancelling a TIA input for lidar. The ideal characteristics of a multiplexed lidar receiving analogue front end would be that it has a high dynamic range, recovers quickly, rejects ambient light, and dissipates little power with unlimited bandwidth. The reality is some of these qualities have mutually exclusive design considerations.

AC versus DC

If AC coupling is chosen, the dynamic range is increased at the cost of recovery time when saturated. AC coupling makes sense for applications that can tolerate tens of microseconds of recovery time for the TIA.

With DC coupling, the recovery rate is much faster at the cost of some or all of the dynamic range being lost from DC effects. DC coupling makes sense in applications that require fast recovery and are not as sensitive to DC effects that may inhibit dynamic range.

If DC coupling with integrated current cancellation is the chosen topology, the dynamic range is increased, saturation recovery speed and channel switching are faster with the requirement of additional design complexity. This topology is a requirement for automotive lidar since the need for fast recovery and more dynamic range are justified for the extra design and costs.

Simply adding an AC-coupling capacitor to the input of the transimpedance amplifier in a pulsed application can harm the performance of the system. However, trade-offs can be made to achieve realistic goals depending on needs.

Not all systems require the best recovery times (for example, industrial and instrumentation systems), and AC coupling can be applied to these circuits.

In cases where the TIA struggles to recover when the input is AC coupled, it is convenient to blame the TIA. However, even with an ideal TIA model with zero recovery time, the recovery time would still be compromised when the AC capacitor is added. This may be a scenario where it might make sense to consider adding DC-coupled or DC-coupled with DC cancellation circuitry.

Input Coupling	DC	AC	DC with current cancellation
Advantages	Fast saturation recovery Fast channel switching Simple to design	Maximum dynamic range even with ambient light and ADP leakage	Maximum dynamic range even with ambient light and ADP leakage Fast saturation recovery Fast channel switching
Disadvantages	Dynamic range loss from ambient light and ADP leakage	Several design considerations Slow saturation recovery	Complex circuit that needs careful considerations

Table 1: Input coupling trade-offs

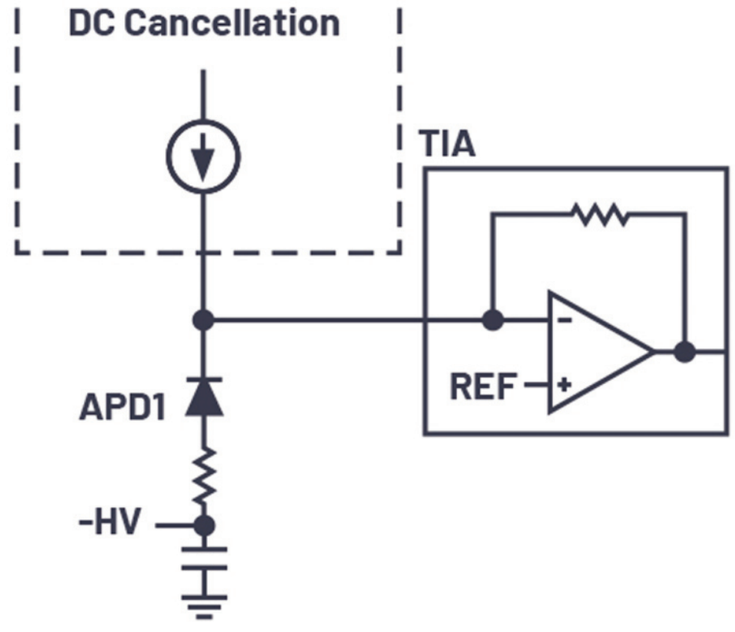


Fig. 9: DC cancellation scheme

Summary

Lidar input is not a trivial topic, and there are going to be many moving parts in the design process. The signal chain is going to be different depending on which design is chosen, so it's important to consider all options before choosing the one that is best for a project.



Noe Quintero is an analogue design engineer and



Tony Pirc an automotive application engineer, both with Analog Devices

LIDAR



SOMEWHERE TO HIDE

Florian Petit looks at lidar's role in autonomous driving

They say science fiction often becomes fact, and that much is true in the world of autonomous driving, and autonomous vehicles. In fact, a semi-autonomous future is just around the corner with automated functions already supporting drivers and making driving safer.

But the process isn't simple, and many manufacturers are tackling speed to market against competitors while never compromising on safety.

One such challenge here is that of level three autonomy, a step in which responsibility is shared between the vehicle manufacturer and the driver, causing safety complications for semi-autonomous vehicles that are set to hit the road.

Safety is the number one concern, and for automotive technology to operate safely at level three, it needs to alert the driver to step in during complicated traffic situations, where at this stage the technology isn't capable of taking action itself. This begs the question of whether level-three autonomy should be prioritised, as the driver's alertness is still required, seemingly defeating the point of autonomous driving.

Because of these hurdles, many new and large players in the market have chosen to skip level-three autonomy completely. Not only does this tackle the issue of safety during circumstances of switching control between car and driver, but it also overcomes other select factors such as insurance – who will be responsible for an accident, the car manufacturer or the driver?

This insurance question results in complications, which will not be easy to put in place. Nevertheless, things are moving here; for example, pragmatic answers could be found for the first level-three licence in Germany for Mercedes, which represents a promising start.

Lidar is a critical part of the journey towards fully autonomous vehicles, as it acts as a remote sensing measurement tool, emitting laser pulses over a broad field of view, with high frequency and precision. This sensor effectively acts as the eyes of a vehicle, so it can detect objects within its laser radius, allowing for immediate changes to take place when required.

To enable car makers to reach higher safety standards during the most complex urban situations, the vehicle must have sensors placed all around the car, imaging an all-round view of its surroundings to detect hazards ultimately from every direction in a timely manner. Recently introduced concepts make this possible at a low cost. What's more, the sensors do not compromise the vehicle's design with bulky attachments.

Of course, lidar is only one piece of the puzzle, but its capabilities spread much further than just the autonomous car space. Many big players within various industries such as mining, agriculture, infrastructure, retail and events are particularly interested in lidar's benefits, specifically in the higher levels of digitalisation as well as increased efficiency and safety, which are huge priorities for many applications within these sectors.

Furthermore, lidar sensors have been previously known to be very large, another factor being deciphered by lidar specialists globally. Large size can also jeopardise safety standards as there is more surface area to be damaged, or with which to damage something.

Very compact sensors are being developed with top car designers to ensure the aesthetic quality of lidar products, especially in an industry where brand style and standards are of the highest level. One answer is seamless integration, by which sensors are hidden within the genetic make-up of a car, for example in the headlights or on the wing mirrors.

This means lidar can be manipulated into each brand's design subtly but effectively.

Leaders in lidar are pointing their efforts towards making a safe, efficient and autonomous future, doing so both for those who choose to commit to level-three autonomy, and those who want to move straight to level four.

Throughout every stage of the process, from adas to level-five autonomy, safety must always be at the forefront.



Florian Petit is Blickfeld's co-founder and chief experience officer

ASSISTED REALITY

SEEING things

Jon Arnold explains how assisted-reality wearables are transforming the automotive ecosystem

The transformation taking place in the automotive industry is at a scale not seen since Henry Ford installed the first moving assembly line in 1913. From design and manufacturing to supplies and logistics, tried-and-true processes that have been used in the automotive industry are finally being shaken up. The change is due to the convergence of many trends.

The future of the automotive powertrain is overwhelmingly an electric one. According to McKinsey, the tipping point in passenger electric vehicle (EV) adoption happened in the second half of 2020, when EV sales and penetration accelerated in major markets despite disruption to the economy due to the Covid-19 pandemic.

And, amid new regulatory targets for EV sales in the EU, USA and other countries, vehicle original equipment manufacturers (OEMs) are now deprioritising investment in internal combustion engine (ICE) vehicles in favour of electric propulsion.

This shift will disrupt more than just automakers and OEMs; it will affect the entire automotive value supply chain, from aftermarket suppliers to body shops to retail dealerships. As electrification of the automobile ramps up, suppliers must shift from ICE to EV components, including batteries, sensors and electric drives. The whole manufacturing and repair process is radically different with EVs, from safety features to test and development procedures.

Skills shortage

Technological advancements are also helping address two significant challenges the automotive sector faces.

First, there are many highly skilled technicians who excel at diagnosing traditional ICE vehicles, but as these auto techs are not generally digital natives, they may experience frustration by the increasing electronic and software complexity present in many newer vehicles. Yet their talents are far too valuable to lose. In those cases, cloud-based learning can play a role in helping upskill them further.

Secondly, the skills shortage crisis has been compounded due to seasoned professionals retiring from the industry faster than they can be replaced. Therefore, the motor industry needs to push digital transformation – and be seen to be embracing it – to entice a younger, tech-savvy demographic to work within the sector.

To provide both demographics with the skills they need to be part of the digital transformation story in a way that, ultimately, benefits customers, it is worth considering the technology they can use day to day to facilitate this.



The motor industry needs to push digital transformation



Product information can be displayed in the line of sight

Assisted reality

One such example of the digital transformation technology needed in the automotive industry is assisted-reality wearables. For those unfamiliar with this auto tech, it refers to voice-controlled wearable head-mounted devices (HMDs).

A technician benefits from a micro-display that fits just below their line of sight and views just like a tablet computer. The technology enables the wearer to communicate via unified communications and collaboration platforms such as TeamViewer for easy communication with remote-based colleagues.

Users can also follow guided workflows and experience data contextual visualisation of parts and data. It is entirely voice controlled and therefore hands-free, a feature that is essential in automotive work environments such as garages or manufacturing areas.

Using Teams, for instance, the expert on the other end of the line sees what the worker sees (point of view) as they observe a specific scenario and can provide advice and expertise in-situ.

For instance, if an auto technician was having issues removing a gearbox on a truck, by using the HMD the technician could contact the original equipment manufacturer rather than waiting on an email or trying to fumble with their personal mobile device. The manufacturer's technical team could then see in real time what the technician was seeing, and advise them about solutions to the problem.

Or, via a secure cloud, the technician could access the manufacturer's product information datasheets, and see them displayed in their line of sight, while their hands are left free to attend to solving the problem.

The convenience is matched by the time saved; a job can be completed more quickly, with a lower labour charge for the

customer. For fleet managers, the cost savings over time have the potential to compound and catch the attention of the company's leadership.

The appeal of this technology is starting to filter across the sector in the UK, USA and beyond. In Turkey, for instance, there has been widespread adoption of this technology by Mercedes-Benz. It rolled out wearable technology across all its 56 authorised service centres in the region. Prior to the country-wide deployment, its process for vehicle after-sales and after-market repairs could include multiple in-person trips, emails, shared photos and videos, and over-the-phone collaboration with subject matter experts to resolve some problems.

With more than 240,000 customer vehicles on the road and the company's commitment to high-quality service, it expects to benefit from an up to 80% performance increase in customer service centre technical problem resolution, and up to an estimated $100,000 in cost savings following the wearable deployment. With fewer trips needed, it also expects the environmental benefits that come from a 500-ton carbon reduction.

Another example is Ford, which is using assisted-reality wearables for remote assistance. Positioned as a "See what I see" option for Ford's technical assistance centre, real-time point-of-view video from a repair technician is paired to a remote expert. The time to fix and overall error rate are greatly reduced. Such has been its success, its scaled implementation will be active in 3000 dealerships.

In line with these applications, Eric Abbruzzese, research director at ABI Research and a top AR analyst, said: 'The automotive market is uniquely positioned to face these complexities, but also interested in reducing those elements across the value chain from the factory floor to the automobile dealership. Complexity is high in all facets – environments, products and processes."

Automotive factory floors are busy and complicated, he said, with little room for worker or machine error thanks to immense scrap and downtime costs.

"The product itself – automobiles – presents incredible complexity through number of parts, assembly and product variation," he said. "Auto service can be equally tricky, especially with new technology requiring training and specialty processes. In each of these areas, complexity can be reduced with wearables and a capable platform supporting it."



The technology lets the wearer communicate with remote-based colleagues



Users can follow guided workflows

Abruzzese went on to list two recommendations for automotive companies considering assisted reality wearables:

- Recognise that there are different levels of integration, with the proper level of integration into existing systems varying in depth based on needs. For example, a remote expertise offering can run as a standalone application but integrating that application with an IoT backend can enable real-time data. The deeper the integration, the greater the potential return but with some added complexity up front. Cloud offerings are helping resolve some of that upfront complexity, and mature enterprise partners and vendors are better prepared for IT and other backend integration that can be a barrier to entry and delay time to value.
- Identify target use cases along with target users and environments. Match needs for those use cases and users to the appropriate device. This increases time to value and reduces AR user churn. Relatedly, educate decision makers and potential users on device options. Three types of devices – mobile, assisted reality and mixed reality – deliver very different experiences while targeting similar key performance indicators (KPIs) such as increasing efficiency and decreasing errors. Even if high data density, found in mixed reality, could provide greater capability and overall value, environmental factors may make mixed-reality devices untenable. Vision is still obscured somewhat with pass-through displays, which needs to be a consideration for safety, usability and compliance.

Ultimately there are many ways wearables can be used to augment, not replace, humans across the automotive ecosystem, irrespective of their skill set. By embracing digital transformation and providing data and real-time information to frontline workers, organisations can reduce the cost of servicing and manufacturing, and make the experience much better and less expensive, and less risky for the customer.



Jon Arnold is vice president for Emea at RealWear

ON THE ROAD

RAVolutionary

Multimedia and safety features stand out for the Toyota Rav4

Toyota has unveiled a series of upgrades for the 2023 Rav4, with enhancements that focus on improving life on board with multimedia systems and a customisable digital driver's instrument display. Safety is enhanced, too, with functions added to the car maker's Safety Sense systems.

The changes are rolled out across the full range of hybrid electric and plug-in hybrid electric models to make the world's best-selling recreational SUV an even more desirable proposition.

Multimedia

The Rav4 adopts Toyota's latest multimedia system, which features a 26.7cm screen with a high-definition colour display.

The standard system provides cloud-based navigation that allows for accurate journey planning with information that's constantly updated, plus live details of traffic and road events and how easy or hard it might be to find a parking place near the destination.

Thanks to the included four-year over-the-air smart service data package, drivers can access Toyota's latest multimedia and navigation systems without having to pair their smartphones to the vehicle.

User experience is seamless with the accompanying MyT smartphone app to keep track of various vehicle information, such as driving analytics, fuel levels, warnings and vehicle tracker.

Smartphone integration with Android Auto is available and, for added convenience, wireless smartphone integration with Apple CarPlay is standard.

There are more ways to communicate with the car using the on-board voice agent that will respond to spoken requests to adjust the climate control, choose multimedia options, make a phone call, or open and close the windows. "Hey Toyota" is designed to understand conversational speech, so if the user says "I'm cold" it will respond by closing the windows or raising the air conditioning temperature.

A further, optional multimedia system is also available, offering additional functions. It introduces an embedded navigation system that will operate when no data connection is available. It also recognises highway signs and can provide local weather alerts and notify the driver of restricted LEZs (low emission zones).



Inside the Toyota Rav4

Remote services

The Rav4 comes with more remote functions the driver can make use of, without having to be in or near the vehicle. The familiar worries about whether a window has been left open, the doors unlocked or the lights on after the driver has walked away from the car are addressed with remote notifications to confirm the vehicle is secure. This feature is standard on all new Rav4 models.

The user can also lock and unlock the doors – a handy feature if someone without a key needs access, for example to drop off a parcel or to clean the car. The hazard lights can be flashed, making the vehicle easier to spot in a big or busy car park. These features are standard on mid-grade models, together with remote operation of the climate control to warm up or cool the cabin before making a journey.

Combimeter

It's a feature of all new Toyota models that the driver can view and take in key vehicle data at-a-glance, so there is least distraction from their focus on driving and the road ahead.

The Rav4 introduces a digital combimeter in the instrument



The driver can choose the most relevant information needed

binnacle that comes with flexible display settings. There is a choice of four styles and three layouts and personalisation options for the large, 31.2cm TFT display so the driver can choose the most relevant information needed between the numerical speedometer and digital dials, as well as other information such as eco-driving meter, song information or adaptive cruise control display, among others.

These layouts are presented in four different style themes for a more customised look-and-feel of Casual, Smart, Sport and Tough.

The unit is standard on all grades apart from the entry-level model which uses a 17.8cm version of the combimeter.

Safety

Toyota Safety Sense functions can warn the driver and help avoid a wider range of common road accident risks.

The pre-collision system (PCS) gains intersection support that can help with safer turns at junctions. It will detect if the car is about to cross the path of any oncoming traffic, and if there are any pedestrians crossing the road into which the vehicle is moving, alerting the driver and, if necessary, initiating braking control to help avoid an impact.

Emergency steering assist is also newly provided, helping the driver avoid a pedestrian who has stepped into the road, while keeping the car under control and within its traffic lane.

On the Rav4 plug-in, the system will also recognise and react to bicycles and parked vehicles. The plug-in's PCS also gains the ability to detect oncoming vehicles in the car's traffic lane and reduce the risk of a head-to-head collision.

Exterior

A Platinum White Pearl exterior colour is being introduced for all grades of the Rav4 plug-in hybrid and hybrid, except Adventure grade. The Style grade will see the introduction of a Platinum White Pearl bi-tone with Midnight Black Metallic for both variants.

Rav4

Introduced in 2019, the Rav4 has reached its fifth-generation with a 2.5-litre hybrid dynamic force engine built on the GA-K platform offering 218 DIN hp in front-wheel drive form and 222 DIN hp with the electric intelligent all-wheel drive (AWD-i), delivering step-changes in power, responsiveness and efficiency, with claimed best-in-class fuel economy and emissions levels.

The plug-in hybrid sits at the pinnacle of the range as the most powerful model yet with 306 DIN hp. Together with a fuel consumption of 1.0litre/100km and 22g/km of CO_2, the plug-in hybrid delivers class-leading power and efficiency.

Production of the 2023 Rav4 began this quarter.

Autosar-compatible MCU meets Asil B and ISO 26262

A 512kbyte flash, 5V, dual Can-FD microcontroller from Microchip is said to deliver premium features typically only available on more expensive, higher performance devices.



The Pic 32CM JH meets ISO 26262 functional safety and ISO/SAE 21434 cyber-security engineering standards. It is the industry's first MCU based on the Arm Cortex-M0+ architecture with Autosar support, memory-built-in self test (MBIST) and secure boot.

Autosar compatibility provides suppliers with the ability to change to lower-level hardware but keep the original application code, making it easier to migrate between different designs. When using Autosar, the firm offers Asil-B microcontroller abstraction layers (MCals) for functional safety applications, providing the lower-level hardware interface to the MCU.

When paired with one of the firm's trust anchor TA100 CryptoAutomotive security ICs, it complies with the ISO/SAE 21434 cyber-security standard for automotive. The TA100 uses secure hardware-based cryptographic key storage and cryptographic countermeasures to eliminate potential backdoors linked to software weaknesses.

The secure boot is part of the hardware.

It authenticates the code to make sure it is valid and prevents malicious code from being loaded onto the MCU.

Other hardware features include error correction code (ECC) with fault injection, loopbacks on the communications interfaces, system memory protection unit and MBIST, all of which are safety mechanisms used to meet ISO 26262 and IEC 60730.

MBIST is the standard method of testing embedded memories and can quickly test the integrity of the sram to ensure it is functioning properly before the code is run to mitigate failures.

To support developers with implementation, the MCU comes with functional safety collateral such as a safety manual, failure modes effects and diagnostic analysis (FMEDA) and diagnostic code targeting ISO 26262 Asil-B safety levels.

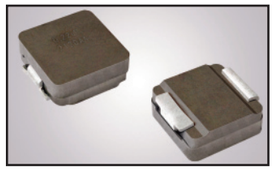
Additionally, it includes touch with driven shield plus, providing noise and water tolerant operability. This feature is necessary for home appliances, industrial and automotive applications where the touch must work in harsh environments.

The MCU is supported by the PIC32CM JH01 Curiosity Pro development kit.

Inductor delivers up to 155A

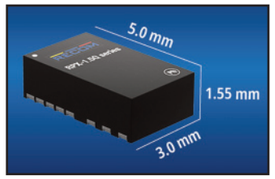
An AEC-Q200 qualified IHSR high temperature inductor from Vishay has current ratings up to 155A in the 19.0 by 17.1 by 7.0mm 6767 case size.

Designed for multi-phase, high current power supplies and input-output filters in automotive under-the-bonnet and adas applications, the IHSR-6767GZ-5A offers a 50% reduction in DCR over typical power inductors and is smaller than ferrite-based devices.



The inductor is optimised for energy storage in DC-DC converters up to 5MHz and high-current filtering. Operating temperature is up to +155°C, and the device is suitable for filtering and DC-DC conversion in adas and lidar microprocessors, 12 and 48V vacuum-less braking, OBCs, and brushless DC electric motors up to 140A.

For these, its typical DCR of 0.24mΩ and inductance of 0.22μH increase current density with no hard saturation and more stable inductance and saturation at the operating temperatures.



DC-DC converters

The Recom RPX DC-DC converters in QFN housings are now also available as Q variants that meet AEC-Q100 grade-one requirements.

Optionally, they can be equipped with wettable flanks for automated optical inspection (AOI). The lead-free and thermally optimised 3 by 5 by 1.6mm housing operates with derating up to well over +100°C ambient temperature, both for the RPX-0.5Q (0.5A) and the RPX-1.5Q (1.5A) variant.

The required inductance is already integrated. For full functionality, only external input and output capacitors adapted to the respective application are required.

On-off control and synchronisation inputs are equipped with a power-good output. The input voltage range is up to 36V. Output can be trimmed from 0.8 to 30V.

The over-moulded flip-chip-on-leadframe construction ensures lower thermal resistance of the enclosure.

They have a soft-start function, and full short-circuit, overcurrent, over-temperature and input under-voltage protection.

Ethernet switch has five optical ports

An Automotive Ethernet switch from KDPOF has five 1000baseRH optical ports, each comprised of the firm's KD9351 FOT and KD1053 phy IC.

The EVB9351-AUT-SW-NXP switch has two SJA1110 switches from NXP on board. This part integrates an Arm Cortex-M7 200MHz processor for autonomous and secure operation, 512kbyte integrated sram as instruction tightly coupled memory, and 256kbyte integrated sram as data tightly coupled memory.

It contains a double-precision floating-point unit and a memory protection unit.

Boot time is less than 100ms with 512kbyte firmware with authentication.

The switch has selectable IO voltages (1.8, 2.5 and 3.3V) to aid in design flexibility.

Footprint is 14 by 14mm with 0.8mm pitch.

It is AEC-Q100 qualified and compliant with ISO 26262 Asil B.

The 2.5Gbit/s operation is supported for two SGMII ports.

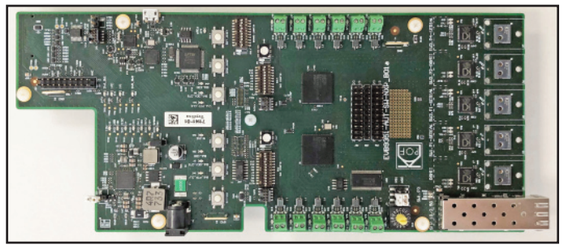
The board has five optical 1000/100baseRH ports, 12 100baseT1 ports and one NXP Sabre expansion connector.

The KD9351 optical interface complements the KD1053 digital interface IC, thus providing a full optical port for in-vehicle gigabit connectivity. The assembly of the FOT and the IC is simplified, and the connector offers snap-fit without soldering.

The devices form a complete automotive 1000baseRHC physical layer.

Constructing the transimpedance amplifier, photodiode, LED driver and LED as one device lowers costs.

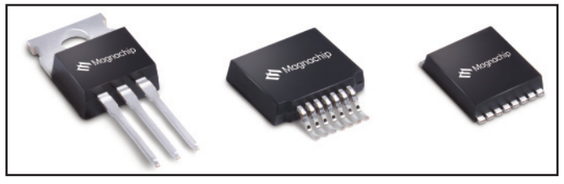
Applications include safe Ethernet backbones, smart antenna modules, and sensor connections for adas and audio-video.



Mosfets for light electric vehicles

Magnachip Semiconductor has introduced its third-generation 200V medium-voltage mosfets for light electric vehicle (LEV) motor controllers and industrial power supplies.

To increase energy efficiency in power devices, the mosfets incorporate third-generation trench technology. The capacitance was reduced by half compared with the previous generation 100V MV mosfet and the design of the core cell and termination helps lower RDS(on) and total gate charge to achieve a high figure of merit.

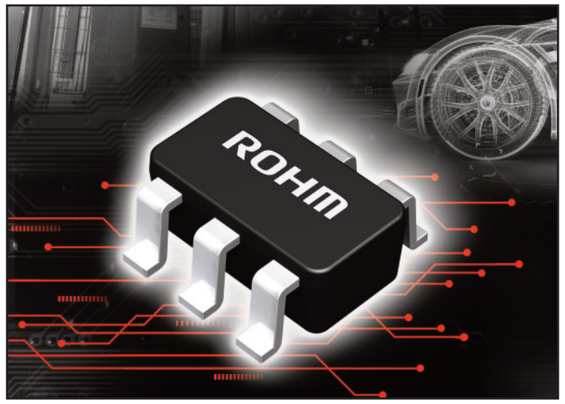


These devices are available in surface mount TO-leadless packages, M2Paks and TO-220s of a through-hole type to reduce product size and enhance heat dissipation.

The energy efficiency is increased by fast switching and high power density.

Guaranteed operating junction temperature is from -55 to +175°C.

Voltage detector accurate for functional safety



A 40V window-type voltage detector from Rohm provides high accuracy and low power consumption for automotive equipment requiring functional safety.

The BD48HW0G-C is optimised for automotive and industrial applications requiring voltage monitoring of electronic circuits for increased safety, including automotive electronic control units and factory automation equipment.

The window-type voltage detector uses a high-voltage bi-cdmos processes along with proprietary analogue design technology. The aim is enabling operating voltages up to 40V and a detection voltage accuracy of ±0.75%.

At the same time, the detection voltage can be freely set, enabling high accuracy monitoring of abnormal voltages from low to high voltage, contributing to reliable systems with few incorrect fault events.

In addition, the detector uses the firm's Nano Energy low consumption technology that reduces current consumption to 500nA.

This enables the carefree application for an increased power consumption in automotive systems powered by battery when the engine is stopped. This also makes it suitable for voltage monitoring in power supply circuits in automotive and industrial applications requiring functional safety.

There are plans to expand the line of high-voltage single-type voltage detectors with fixed detection voltage equipped with Nano Energy technology.

Operating voltage is from 1.8 to 40V and detection voltage accuracy is ±0.75% over the entire temperature range.

Applications include inverters in EVs and HEVs, electronic control units, adas, and in-vehicle infotainment.

Tool update automates model-based design

MathWorks' latest release of Matlab and Simulink platforms provides design tools and models for battery systems.

Allowing engineers to create digital twins, the update provides the software to run virtual tests of battery pack architectures, design battery management systems and evaluate battery system behaviour across normal and fault conditions.

The tool also automates the creation of simulation models that match desired pack topology and includes cooling plate connections so electrical and thermal responses can be evaluated.

Called R2022b, it can simplify and automate model-based design.

Tools include the Autosar blockset to develop services-oriented applications using client-server ARA methods and deploy them on embedded Linux platforms. The tool lets users define data types and interfaces in an architecture model.

The fuzzy logic toolbox lets users design, analyse and simulate fuzzy inference systems (FIS) interactively using the updated fuzzy logic designer app. Engineers and researchers can design type-two FIS using command-line functions or the app.

The HDL coder generates optimised System C code from Matlab for high-level synthesis and uses the frame-to-sample conversion for model and code optimisation.

The model predictive control toolbox uses neural networks as prediction models for nonlinear model predictive controllers. The toolbox lets users implement model predictive controllers that meet ISO 26262 and Misra C standards.

The system identification toolbox creates deep learning-based nonlinear state space models using neural ordinary differential equations.

Machine-learning and deep-learning techniques can also represent nonlinear dynamics in nonlinear Arx and Hammerstein-Wiener models.

Lin regulator targets 12V charging

An automotive alternator regulator from ST Microelectronics has features to ensure the stability of 12V vehicle electrical systems.

The L9918 regulator contains a mosfet to deliver alternator excitation current and a freewheeling diode to handle the rotor current when excitation is turned off.

Closed-loop operation with load response control (LRC) and return LRC maintains a consistent voltage as the vehicle's overall power demand changes continuously.

The excitation mosfet can deliver up to 13A to the coil to improve response to fluctuating demands.

With integrated non-volatile memory, it lets users programme parameters including the voltage set point and alternator characteristics. It can be used with alternators that have up to nine pole-pairs to address different charging applications.

Also integrating a Lin bus interface, it can be connected to the vehicle's electrical and electronic infrastructure to be managed by an external ECU.

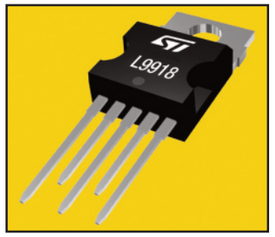
The ECU commands settings including the target voltage and reads status and diagnostic data.

Safety and failsafe features include self-start activation by phase signal, which independently maintains the alternator voltage set point if the Lin connection is lost for any reason. The regulator returns control to the ECU when communication is restored.

Current limitation, overcurrent protection and thermal protection are built-in, as well as thermal compensation that automatically adjusts the target voltage as the system temperature changes.

Compliant with the VDA Lin alternator regulator specification, the device is AEC-Q100 qualified, ISO 26262 compliant and Asil-B ready for functional-safety systems.

The device is in production and sampling now, and is available as bare die and in a Pentawatt in-line TO220-5 package.



Ammonia analyser suits in-vehicle development

The ECM 5250 NH_3 ammonia analyser from Labcell is for use in automotive dynamometers and in-vehicle development and test of diesel and lean-burn engine SCR (selective catalytic reduction) systems.

A large, clear display shows measured values, and the back of the instrument has Can, USB and RS232 ports, plus six analogue outputs.

At the same time, the firm is launching the environmentally-sealed NH_3 Can module for in-vehicle applications where the requirement is simply for a Can output.



These instruments can help improve engine efficiency and emissions.

Both instruments use a solid-state ceramic sensor that is mounted in the exhaust, controlled by either the analyser or module.

These can be connected to a dynamometer data acquisition and control system or, for in-vehicle applications, many operators will use the Can signal output directly with an existing software platform, data acquisition system or laptop computer.

The Can output lets the instruments be used in the loop of a real-time emissions control strategy where urea is being injected to control ammonia levels. While the 5250 analyser can operate in either single-channel or dual-channel mode, the NH_3 Can module is a single-channel device.

Because the sensor is fitted in the exhaust, there is no need for sample lines or pumps, which makes installation straightforward. Furthermore, the sensor can be located up to 100m from the analyser with no loss of response time (less than one second) or accuracy (±5ppm).

Buck switcher IC delivers 850mA

A high-current part has been added to Power Integrations' LinkSwitch-TN2Q automotive switcher IC family.

It provides up to 850mA of output current without the need for metal heatsinking.

The integrated ICs support an input voltage of 30 to 550V DC, enabling the devices to start up and operate below the required SELV threshold in functional-safety EV applications.

The 850mA represents an increase of 230% in available output current compared with other members of the family. LinkSwitch-TN2Q ICs reduce part-count by including control, driver, protection circuitry and a 750V power mosfet in an SMD package.

The ICs are AEC-Q100 qualified and support buck, buck-boost and non-isolated flyback converter topologies.

Each device incorporates a 750V power mosfet, oscillator, on-off control, a high-voltage switched current source for self-biasing, frequency jittering, fast cycle-by-cycle current sensing and current limit, hysteretic thermal shutdown, and output over-voltage protection circuitry in a monolithic IC.

They consume little current in standby, resulting in power supply designs that meet less than 50mW no-load at 400V DC input.

Protection features enabling safe and reliable power supplies include protection against input and output overvoltage, device over-temperature, lost regulation, and power supply output overload or short-circuit faults.

A reference design kit, RDK-707Q, is available for designers wishing to evaluate the family.





PCB relays fit tight spaces

Three PCB relays from Omron target automotive and mobility applications where space is tight.

The G8K, G8G and G8PM relays support DC motor control with a floor size and volume that is up to 95% smaller than similar relays. The devices are smaller than standard DA relays and deliver high contact pressure with increased coil size combined with 500V AC insulation capacity.

The G8K devices are for short-term switching in applications such as automotive comfort electronics, for example seat controllers, door lock motors and sunroof motors. An optional twin version (two joined together) increases mounting density.

With 37A short-term and 5A continuous current carrying capacity, and a durability of 100,000 operations at rated load, they deliver high-wattage switching despite the compact format due to the contacts and heat-release design.

As a direct replacement for micro-ISO plug-in type relays, the G8G relay is for use in engine bays thanks to their high heat resistance, while its small size facilitates high-density mounting.

It is a 24V type suitable for commercial vehicle applications such as in seat heater, door lock, seat controls and defroster.

The G8PM series has a patented contact structure that holds the carrying path for high contact reliability. Designed as a replacement for traditional mini ISO relays, but at around half the size and with a capacity for up to a million operations, these devices suit heavier-duty automotive applications such as motor radiator fans, power steering, fuel pumps and starter motors.

These high-power DC switching PCB relays offer 14V DC, 45A switching (resistive), with 40A carry current at +125˚C ambient temperature.

Microcontroller ups connected-car security

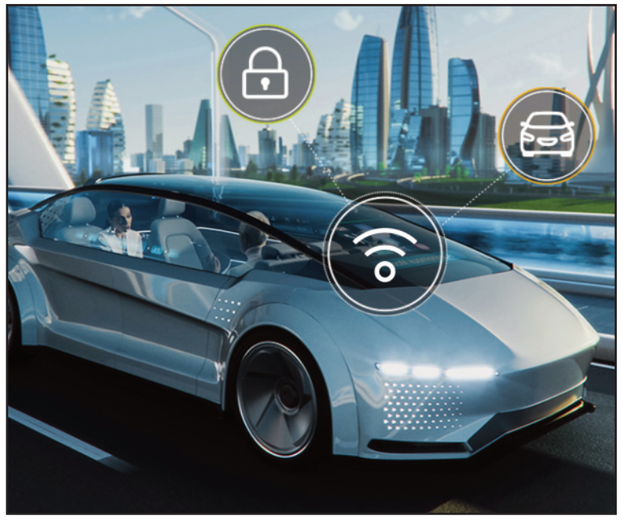
An automotive-qualified secure microcontroller from NXP has cryptographic accelerators and physical built-in electrical attack resistance for security-critical automotive applications such as smart access key fobs, Qi 1.3 authentication or car-to-cloud communication.

The NCJ37x secure element (SE) supports the protocols from the Car Connectivity Consortium (CCC) and its passive NFC ISO 14443-4 interface and secure design addresses the needs of smart fobs combining UWB, Bluetooth Low Energy and passive NFC technologies.

Car makers are adopting smartphone access systems and evolving their smart fobs towards the higher security levels and wireless interfaces familiar from the smartphone world. This enables use cases for smart fobs such as having digital keys for several cars stored on the fob, and adding other payment means such as bank cards.

To meet these needs, OEMs are looking for an open, multi-option platform with higher security and flexibility that can accelerate time to market.

The SE works with the firm's NCJ38x car-side SE and corresponding secure applets. The passive ISO 14443-4 NFC, SPI and I²C interfaces help enable protection against latest attack scenarios. An extended feature set is for secure in-car applications entering the market requiring the secure processing of sensitive data.



The NCJ37x features the Java Card Operating System (JCop), trust provisioning service and secure over-the-air updatability.

The SE enables Common Criteria EAL 6+ certified security for car access, driver authorisation, CCC digital key, car-to-cloud (C2C) communications and Qi 1.3 authentication. The passive, or powered-by-the-field, NFC interface can be a backup if the fob battery is drained.

With 600kbit of secure flash, it provides sufficient memory to allow a multi-service approach considering several active security domains and apps on the device.

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