VEHICLE electronics

The monthly magazine for automotive electronics engineers

Uber gives self-driving car unit to start-up Aurora

Uber has passed its autonomous vehicle research unit to Californian start-up Aurora.

Aurora was founded in 2017 and is building the Aurora Driver, a platform that brings together software, hardware and data services to operate passenger vehicles, light commercial vehicles and heavy-duty lorries.



Uber self-driving research vehicle

The company is backed by Amazon and Sequoia, and tests its vehicles in California, Pittsburgh and Dallas. The company has offices in those three cities and in Montana.

Uber is investing $400m in Aurora and Dara Khosrowshahi, CEO of Uber, is joining Aurora's board.

"Few technologies hold as much promise to improve people's lives with safe, accessible and environmentally friendly transportation as self-driving vehicles," said Khosrowshahi.

Uber's research turned into a nightmare for the company in 2018 when one of its self-driving vehicles killed a woman in Arizona.

Japanese firms Toyota and SoftBank have both invested heavily in Uber's autonomous vehicle research.

"By adding the people and technology of Uber's advanced technologies group [ATG] to the incredible group we've already assembled at Aurora, we're shifting the landscape of the automated vehicle space," said Chris Urmson, co-founder and CEO of Aurora. "With the addition of ATG, Aurora will have an incredibly strong team and technology, a clear path to several markets, and the resources to deliver. Simply put, Aurora will be the company best positioned to deliver the self-driving products necessary to make transportation and logistics safer, more accessible and less expensive."

Aurora also announced a partnership with Uber that connects its technology to the ride-hailing platform and strengthens its position to deliver the Aurora Driver broadly.

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Renesas and FAW establish joint research lab

Renesas and car maker FAW have established a joint laboratory in Changchun, China, to build a development platform for intelligent driving.

It will let the two companies jointly develop ECUs for autonomous driving, intelligent cockpits, powertrain and body control.

The first products developed in the laboratory will be applied to FAW's flagship brand Hongqi.

FAW is developing intelligent and connected vehicles that meet needs for connectivity, automation, shared and social, and electrification. To realise smart mobility, it wants to build its own intelligent driving development platform.

"FAW is committed to strengthening independent development capabilities for new intelligent, connected vehicles," said Li Dan, vice president of FAW's R&D centre. "The in-depth cooperation with Renesas, a trusted supplier of leading automotive processors with excellent technological expertise, will no doubt enrich semiconductor device options for our intelligent driving development platform and strengthen our ability to define automotive architecture and requirements for China's automotive market. The joint laboratory will play an important role in the development and commercialisation of ECUs, and we will strive to bring the ultimate driving experience to end users."

As a supplier of automotive processors, Renesas provides semiconductors as well as expertise for smart mobility.

Based on Renesas automotive processors, including the RH850 MCUs, R-Car SoCs, and power and analogue devices, the companies will develop a complete automotive controller development platform that meets functional safety and security standards.

Valeo adapts adas for e-bikes



Valeo is taking technology such as adas and 48V electrification developed for automotive and applying them to smart e-bikes.

It has adapted its 48V motors resulting in what it says is the most high-performance electric assistance system for bikes.

The bike integrates an electric motor and an adaptive automatic transmission in the pedal assembly. With this, the bike adapts to the cyclist; the gears change automatically and algorithms instantly adapt to the amount of electric assistance the cyclist needs from the first pedal stroke.

The technology developed in partnership with Effigear comprises a 48V electric motor and a seven-speed automatic, adaptive gearbox in the pedal assembly. Given the motor's torque of 130Nm, it can multiply the cyclist's effort by eight.

Used on a cargo bike, a cyclist carrying a 150kg load can climb a 14% gradient without breaking a sweat. The electric motor is also more efficient than the 24 or 36V motors installed on most e-bikes today.

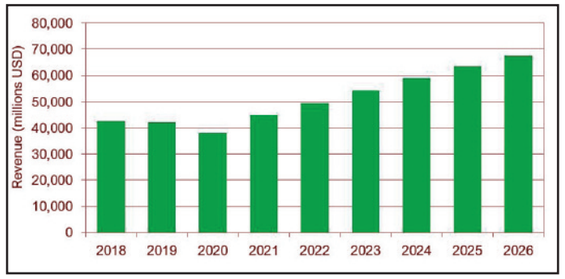
An algorithm understands and instantly adjusts to each person's needs, taking into account their riding style and journey. The gears shift smoothly, with no buttons or levers needing to be pressed.

Automotive semiconductor revenues beat expectations

Global automotive semiconductor revenue for 2020 is forecast to exceed initial expectations, primarily due to an increase in the average semiconductor value per car sold, according to IHS Markit.

The market watcher now expects semiconductor revenue to contract in 2020 by 9.6% to just over $38bn, which contrasts to the mid-year view where semiconductor revenues were expected to drop 20% by year end compared with 2019.

IHS continues to anticipate robust growth in 2021 reflecting improved demand and production conditions and especially a further uptake in electric vehicles, one factor that helped boost the semiconductor market in 2020.



Automotive semiconductor revenue from 2018 to 2026

Two factors are driving the recovery, notably low automotive inventory that will result in new car growth in 2021, combined with stimulus packages designed to benefit the ailing car sector while favouring the switch to electric and hybrid cars, which are typically more expensive than equivalent internal combustion-driven models.

Both hybrid and electric vehicles have more expensive power semiconductor content to control components such as traction motor inverters and DC-DC converters, but the electrification trend also supports autonomy features and advanced infotainment, even in the smaller car segment.

One of the impacts of Covid-19 is it has led to an increase of the average semiconductor value per car sold. In some parts of Europe, for instance, the government is only providing incentives for electrified vehicles. This differs from the cash-for-clunkers type of initiative employed in certain regions following the 2009 financial crisis designed to get older vehicles off the road.

In many cases this favoured sales of smaller, less electronically equipped vehicles. Additionally, today's hybrid- and electric vehicles are also fitted with more autonomy-related features and more advanced infotainment and HMI systems, even in the lower cost segments.

The shift in propulsion type in part created by the pandemic is not a momentary burst and higher levels of electrification will propel the market for semiconductors well past 2021, itself a year expected to see a market-corrective expansion of 18% over 2020.

By 2026, IHS forecasts the global market for automotive semiconductors to reach $67.6bn, a healthy compound annual growth rate of 7% from 2019 to 2026.

Millbrook and Utac Ceram merge on vehicle testing

Utac Ceram and Millbrook are merging their operations to create a group for vehicle testing, homologation and emerging technologies for autonomous, connected and electric vehicles.

Millbrook brings expertise in automotive electric driveline development, in particular through its battery and electric drivetrain test centres in the UK and USA.

These services will complement Utac Ceram's expertise in adas and Euro NCap testing and in cyber security, connectivity and simulation, as deployed in its Teqmo autonomous vehicle test centre.

The group will operate several test centres – in France at the Linas-Montlhéry and Mortefontaine facilities, in the UK in Bedford and Leyland, in the USA in Detroit and California, in Finland at a vehicle test facility with indoor and outdoor winter testing tracks, and in Morocco with a test centre offering a track where vehicles are exposed to extreme heat, and scheduled to open in 2021.

The group will deliver complex certification and testing programmes; testing of vehicles and tyres in hot and cold climates; designing and delivering bespoke customer offerings; and working with global brands to develop connected EVs.

The group will be headed by Laurent Benoit, current president of Utac Ceram.

The transaction is expected to be completed early in 2021, subject to the normal clearances.

Unex and Microsec secure V2X communications

V2X provider Unex is working with Microsec to deliver secure and robust V2X communications.

In V2X traffic, plenty of messages are transmitted at the same time. The role of V2X security is to assure all participants' communications are in secure and trusted operations.

Microsec offers a PKI public key infrastructure background that provides security for vehicle manufacturers, vendors, roadside and onboard unit developers, transportation, and smart city infrastructure operators.

By issuing certificates to road users, Microsec is delivering the trust component for the secure and reliable message exchange among vehicles and roadside equipment.

Unex's latest products contain V2X systems-on-module, on-board units (OBUs), roadside units (RSUs) and V2Xcast, an integrated and modular framework that provides V2X communications and supports V2X deployment on stand-alone OBUs and RSUs or application hosts with flexibility and scalability.

For trusted communications, Unex V2X devices need to secure every message. This is where PKI comes in. PKI systems issue certificates to verified participants. Certificates prevent unauthorised users from sending or modifying the messages. The cooperation is focused on the seamless application of bootstrapping, enrolment and acquisition of certificates between V2Xcast and Microsec's CCMS cooperative intelligent transport systems credential management system.

"V2X technology is still evolving," said JY Ou, Unex VP. "The non-line-of-sight feature helps road traffic to be safer and smarter, however, wireless communication also raises concerns about tampered or fake data. This is why security and authenticity issues are things we must face."

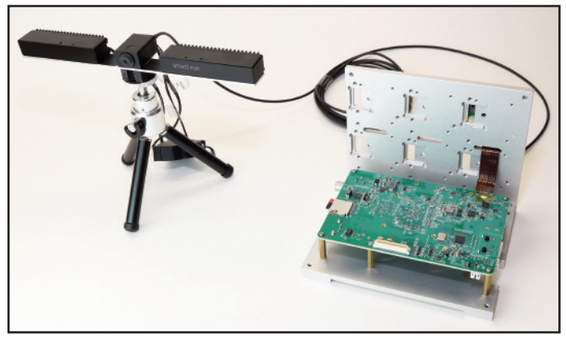
The joint offering is an enabler that accelerates the safety deployment of road traffic management such as collision avoidance and hazard detection, emergency brakes, and truck platooning.



Omnivision combines driver monitoring and videoconferencing

Omnivision, AI vision silicon company Ambarella and Smart Eye, a developer of AI-powered eye, mouth and head tracking technology, have created a reference design for dual-mode camera applications.

It simultaneously monitors drivers while capturing vehicle occupants for one-way videoconferencing.



Reference design combines driver monitoring and videoconferencing

Omnivision's OV2312 image sensor has a dual-mode global shutter that captures both RGB colour images and IR images under low-light conditions. These dual captures are then processed simultaneously by Ambarella's CV22AQ CVFlow computer vision processor, which runs Smart Eye's algorithms to analyse the driver's state and alert the vehicle to any unsafe indicators, such as drowsiness.

"Our CV22AQ offers best-in-class image processing and high performance AI computing at low power consumption, typically below 2.5W," said Fermi Wang, CEO of Ambarella. "While we have worked together to pre-tune this, designers still have the flexibility to further customise it to the needs of their implementations."

The companies worked together to integrate and fine-tune this complete reference design for automotive designers.

The companies are talking with automotive OEMs regarding the implementation of this reference design in upcoming car models.

It enables the full range of driver and cabin-monitoring implementations, from safety applications to augmented reality displays and interior sensing with deep neural networks and AI. One-way video conferencing allows remote conference participants to see those in the vehicle, while the vehicle receives only audio to reduce driver distraction.

"Our AI software makes it possible for automotive OEMs and tier-ones to deploy a new generation of driver and in-cabin monitoring systems with advanced AI features, increasing safety and convenience for drivers and passengers," said Martin Krantz, CEO of Smart Eye.

The OV2312 is a dual-mode automotive image sensor, enabling single-camera driver state monitoring and viewing applications, such as the videoconferencing capability in this reference design. It provides Asil functional safety and near-infra-red light performance of 14% quantum efficiency at 940nm wavelength. Its power consumption is 190mW in typical conditions.

"Our OV2312 is the only automotive image sensor that offers the combination of dual-mode RGB-IR capture and a global shutter," said Mario Heid, vice president of Omnivision. "Without this combined functionality, the camera system designers would have to use two separate image sensors, which is too expensive for most vehicles."

DSpace and LeddarTech partner

DSpace and LeddarTech have entered a partnership to drive forward the development of lidar for adas and autonomous driving (AD).

This cooperation could lead to simulation tools and models to support and accelerate the development and validation of tailored LeddarEngine-based lidar sensors and adas and AD systems.

These tools let users simulate their own LeddarEngine-based lidar sensor designs versus integration of third-party black box lidars. Simulation helps designers explore various lidar sensor architectures and components in development and validate the resulting performance.

Rohm and UAES open SiC laboratory

Rohm and tier-one automotive manufacturer United Automotive Electronic Systems (UAES) have officially opened their joint laboratory on SiC technology in Shanghai.

SiC power devices are being increasingly adopted in electric vehicles. SiC-based products provide advantages over silicon-based devices such as reduced loss during switching and conduction. They also support higher temperature operation.

Since 2015, UAES and Rohm have been collaborating and carrying out detailed technical exchanges on automotive applications using SiC power devices. Automotive products incorporating Rohm SiC power devices were released in 2020.

"With Rohm, which has been introducing SiC power devices since 2015, we have strengthened our collaboration, including top management," said Guo Xiaolu, UAES deputy general manager. "And after many years of technical exchanges, we are pleased to announce the successful development and mass production of SiC-equipped automotive applications. The establishment of this joint laboratory is a testament to the deepening relationship between our two companies, and we can look forward to further technical support through this new comprehensive facility."

The joint laboratory contains equipment required for device and application evaluation in automotive such as on-board chargers and DC-DC converters. This should allow the companies to strengthen their partnership and accelerate the development of power components centred on SiC.

"We are pleased to have established a joint laboratory with UAES, a leading manufacturer of automotive applications," said Kazuhide Ino, senior director at Rohm. "As a leading supplier of SiC power devices, Rohm develops industry-leading devices and has a proven track record of providing power solutions that combine peripheral components such as driver ICs. And in the rapidly expanding automotive sector, as research tailored to customer needs and market trends becomes an important factor, we will continue to strengthen our partnership through this joint research lab and contribute to technical innovation in the automotive sector with power centred on SiC."



Raita Fujimura (left), chairman of Rohm in Shanghai, and Guo Xiaolu, deputy general manager of UAES

TI uses Imagination for Jacinto

Imagination Technologies' BXS-4-64 GPU will be included in Texas Instruments (TI) Jacinto processor families for automotive applications.

The BXS is said to have up to 60% higher performance for automotive graphics applications, such as surround view technology, thanks to its bespoke design.

The is the firm's first XS GPU IP with added safety features and a design process conforming to ISO 26262. It includes Imagination's B series multi-core architecture, which incorporates features and safety mechanisms such as tile region protection and hardware virtualisation.

"Imagination's BXS GPUs enable us to introduce differentiated automotive processors with higher performance, lower bandwidth and enhanced safety capabilities," said Jim Kennedy, platform engineering director at TI. "The multi-core technology also helps us scale our technology for future processor designs."

Jamie Broome, senior director at Imagination , added: "This licence is for a core that is a step beyond anything we've delivered before."

Denso picks Foretellix to improve adas safety

Denso has selected Foretify, Foretellix's verification platform, to enhance safety and reduce development costs and time-to-market for its adas and automated driving offerings.

The platform allows for a reduction in cost of failure by identifying bugs, edge cases and unknowns early in the development cycle. It reduces recalls, as well as lowering the cost of testing by providing productivity gains through automation.

It also allows for a reduction in time to deployment of adas and automated driving functions by using proven coverage-driven methodologies.

Foretellix recently released an adas and highway version that provides an out-of-the-box library of scenarios, test suite and a reference verification plan designed to deploy current and future automated driving functions.

"Denso considers the quality and safety of its adas and autonomous vehicles of the outmost importance," said Tasuku Hayakawa, manager of Denso in Germany. "Following a successful pilot earlier this year, Denso decided to collaborate with Foretellix and to use the Foretify platform with a number of Denso's adas. We see the potential of Foretellix's intelligent verification platform to enable Denso to ensure safety as we scale from adas to advanced driving."

Ziv Binyamini, CEO of Foretellix, added: "It's a privilege and an honour to work with Denso, a leader in advanced driving systems. We share a common vision on the importance of uncompromising quality and safety."



Automated driving vision



NetModule's NG800 automotive gateway

U-Blox and NetModule partner on telematics

U-Blox is working with NetModule to develop modular, multifunctional automotive gateways for telematics applications.

NetModule's NG800 automotive gateway platform uses the U-Blox Toby-L2 cellular module, Neo-M8L GNSS receiver and, in some products, the Jody-W1 wifi module.

NetModule designed the automotive IoT gateway to offer robust communication between a vehicle's on-board electronics and connected cloud based applications enabling a broad spectrum of automotive use cases, including e-mobility monitoring, fleet management and remote vehicle diagnostics.

"The key components in the NG800 are sourced from U-Blox," said Benjamin Amsler, director of engineering at NetModule.

NetModule provides the management software and connection monitoring on top, while the remote management of eUICC sim profiles have been implemented in cooperation with U-Blox.

The Toby-L2 provides global connectivity while the Neo-M8L with dead reckoning provides robust positioning, even in typically challenging environments.

Municipalities can equip garbage collection, street cleaning and winter maintenance vehicles with the gateway to monitor activities, itineraries and status, gathering real-time data.

The NG800, which combines LTE Cat 4 cellular communication, Bluetooth Low Energy short range radio and GNSS positioning with dead reckoning, also uses a Molex CMC 48-pin connector to accept wired inputs such as Can, RS232, Automotive Ethernet 100baseT1 and Fast Ethernet 100baseTX.

Housed in an IP69-classified case, the NG800 is designed to withstand harsh handling, making it tough enough to be mounted on the vehicles' exteriors.

Ford steers drivers from blind spot danger

Ford has introduced technology designed to help drivers avoid blind spot collisions while travelling on multi-lane carriageways.

The lane-keeping system with blind spot assist makes its global debut on the Kuga SUV. The technology monitors the driver's blind spot for vehicles approaching from behind, and can apply counter-steering to warn the driver and discourage a lane change manoeuvre if a potential collision is detected.

"Many drivers will at some point have been caught by surprise when another vehicle seemingly appears out of nowhere," said Glen Goold, Kuga chief programme engineer. "Lane-keeping system with blind spot assist is like having an extra pair of eyes in the back of your head, helping prevent just a second's lapse in judgement from escalating into something more serious."

For more than a decade, Ford has offered blind spot information technology that can alert drivers to the presence of vehicles in their blind spot using a warning light in the door mirror.

Lane-keeping with blind spot assist goes a step further by applying a gentle force to the steering wheel to discourage drivers from changing lanes into the path of another road user and guide the vehicle away from danger.

Radar sensors scan parallel lanes for vehicles up to 28 metres behind, 20 times per second, while driving at speeds from 65 to 200km/hr. An intervention can be automatically activated if the control system senses a lane-change by monitoring road markings using the forward-facing camera, and the technology calculates that the two vehicles are on a collision course.

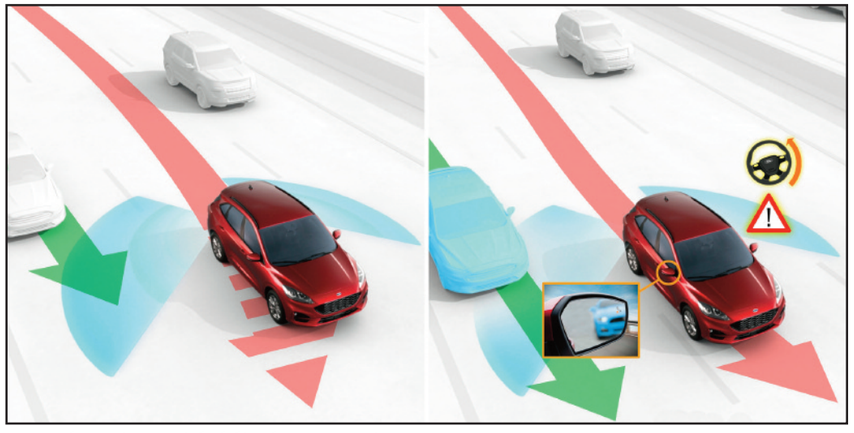
It can intervene to help prevent collisions with vehicles approaching with a closing speed of up to about 30km/hr.

Also making its global debut on the Kuga, intersection assist technology uses the vehicle's forward-facing camera, combined with radar, to monitor for potential collisions with oncoming vehicles in parallel lanes.

The technology can automatically apply the brakes when travelling at up to 30km/hr to help prevent or mitigate the effects of accidents where a driver is turning across the path of an oncoming vehicle, such as commonly encountered at crossroads or mini roundabouts.

Because it operates without the need to detect road furniture such as lane markings or kerbs, it can even intervene in car parks, worksites or other locations without clear markings or traffic priorities.

Both technologies can operate in daylight and in darkness with headlights activated.



Lane-keeping with blind spot assist

Mitsubishi picks TomTom for Eclipse Cross

Mitsubishi has chosen TomTom's full stack of navigation components – maps, connected navigation and real-time traffic services – to power the Eclipse Cross' infotainment system.

The restyled SUV is the latest Mitsubishi model to be equipped with TomTom's automotive-grade technology.

Other models include the Outlander, ASX-Outlander Sport-RVR, and Pajero Sport.

TomTom teamed up with What3Words to bring its addressing technology to Mitsubishi drivers around the world, even when offline.

No app, data or cellular connection is required to input or navigate to a What3Words address.

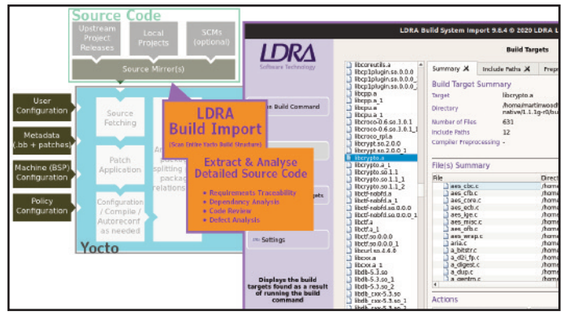
LDRA integrates with Yocto to test complex systems

LDRA has integrated with Yocto, a collaborative project that enables developers to build on open source tools to create complex embedded systems.

Leveraging a build import within its tool suite, LDRA integrates into these complex projects, enabling embedded developers using Yocto to jump through layers of abstraction in diverse and complex build systems and quickly extract the information they need for static and dynamic analysis, as well as unit test.

Yocto's aim to unify and improve software practices in open source embedded systems is complemented by LDRA's goal to facilitate modular design through the re-use of these components in safety critical systems.

Automotive companies already using LDRA's build to test entertainment systems, airbags and brakes have increased the safety and security of these Yocto-integrated systems as they bridge into autonomous vehicles.



LDRA's build import analyses what is taking place within Yocto

"As embedded projects have evolved to complex computer systems, build technology brings the various modules together, and requirements around safety, security and quality become increasingly complex to verify," said Ian Hennell, operations director at LDRA. "No one person can know exactly how each module is built, nor how the code interacts between the modules. Because LDRA's build import shows how code is built, it uncovers the exact information needed for standards compliance and application certification."

Native for Linux, Windows and MacOS, LDRA's build import is extensible and API ready, making it easy to customise. Used with the LDRA tool suite, embedded developers can move directly into static analysis and unit testing of their application. Historically, applications such as braking systems were embedded into a specific microcontroller, and developed and tested independently from the rest of the system.

Automotive systems, however, are following the trend of integrated modular avionics architecture, and embedding a controller is now a software module built into a larger system.

When it comes to functional safety testing in this environment, the ability to decompose the system and understand each module is critical, particularly since tools such as Yocto, while helping structurally organise a system, create a lack of transparency that increases complexity. With the build import, the testing team always has a build expert on staff to offer the answers required to build a safety case.

To certify complex systems to rail's IEC TC 9, automotive's ISO 26262 and aerospace's DO-178C, where rigorous static and dynamic analysis and unit testing are mandated, embedded developers need to analyse fully how the individual modules and systems are built and interact. The build import integrated with Yocto shows the power and flexibility afforded by the build import methodology.

Brake-to-steer adds safety layer

Leveraging technology from its parent companies Nexteer and Continental, CNX Motion has developed brake-to-steer (BtS) that provides driver safety through an additional layer of directional control for automated and autonomous vehicles.

In highly automated vehicle applications, steering systems have multiple protective layers to ensure the safety net is always on. BtS adds another layer by using the electronic brake system to steer the vehicle safely while simultaneously controlling its speed.

In a fully autonomous vehicle with no steering wheel present, BtS could negotiate a commanded path until a safe pull-over can be achieved.

Telechips picks Arm for automotive SoC

South Korean fabless semiconductor company Telechips has selected a suite of Arm IP for its next automotive SoC, the Dolphin 5, designed for applications such as adas and digital cockpits including IVI systems.

To meet Telechips' performance, safety, power and scalability requirements, the design will include the Arm Mali G78AE graphics processor with functional safety capabilities along with the Cortex-A76 processor and Ethos-N78 neural processing unit (NPU).

Additionally, Telechips has signed up for Arm Flexible Access, which includes several Arm IP safety packages that can be designed into any Telechips SoC without an up-front licensing commitment.

"Our collaboration with Arm gives us access to IP, such as the Mali-G78AE, that is uniquely designed for automotive applications and the complex processing power, efficiency and safety capabilities required for modern vehicles," said Leanne Lee, vice president at Telechips. "By selecting a comprehensive heterogeneous Arm compute, we are well-positioned to successfully develop our next-generation platform to meet the needs of global automotive manufacturers."

For design services, Telechips is collaborating with Arm design partner Gaonchips for its experience in using the Samsung Foundry process and infrastructure for Arm-based SoCs.

The G78AE is designed to deliver a rich user in-vehicle experience combined with the safety functionality for autonomous applications through flexible partitioning, a feature that enables four fully independent partitions for workload separation in safety use cases.

The Cortex-A76 enables a smartphone-like experience and responsiveness for the multiple applications running in parallel on different screens in the digital cockpit.

By integrating the purpose-built Ethos-N78 NPU with the Cortex-A76 and G78AE, Telechips should strengthen the overall machine-learning performance and efficiency of the Dolphin 5 SoC. The Ethos-N78 has performance scaling from 1 to 10Tops.

"Next-generation IVI and adas applications demand a combination of safety, scalability and power-efficient compute," said Chet Babla, vice president at Arm.



Telechips has picked Arm for its latest automotive SoC

R&S and IHP characterise D band

Rohde & Schwarz and the IHP have become the first to characterise D-band frequencies in an over-the-air test setup for 6G and automotive radar.

The IHP – Innovations for High Performance Microelectronics – is a non-university research facility that belongs to the Leibniz Association.

Academia and key industry players have identified the D band, ranging from 110 to 170GHz, as a candidate for beyond 5G and 6G mobile communications as well as for future automotive radar applications.

R&S is continuing its sub-THz research efforts with a focus in this frequency range. In collaboration with IHP, it has performed the industry's first full 2D-3D antenna characterisation of transceiver modules operating in the D band.

R&S and the IHP have demonstrated full 2D-3D over-the-air measurements of a radar module at D-band frequencies.

The test setup consists of the R&S ATS1000 antenna test system, ZNA43 vector network analyser and AMS32 antenna measurement software.

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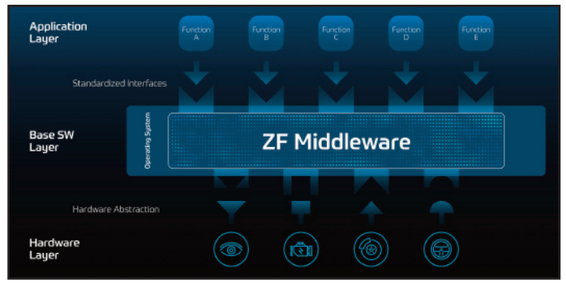
ZF middleware acts as in-vehicle mediator

ZF has developed middleware in the form of an open software platform that acts as a mediator between a vehicle's operating system and its software applications.

Key functions of the middleware are the abstraction of computing hardware from software applications and the communication between these applications.

"The new middleware underpins ZF's claim to be one of the world's leading system suppliers for the software-defined car of the future," said Dirk Walliser, senior vice president at ZF. "Our customers benefit from accelerated development processes and significantly reduced complexity when integrating hardware and software. Throughout the vehicle's lifetime, functions can be updated or additionally offered on-demand."

The middleware will be available in series vehicles from 2024. Its development is connected to the development of application software for mobility domains such as automated driving, integrated safety, vehicle motion control and electric mobility.



ZF middleware acts as a mediator between operating system and applications

Being a connector to the software applications and the hardware components of a vehicle, only the middleware needs to be connected to the operating system. This approach reduces the interfaces, speeds communication with all parts of the system and can help significantly reduce complexity.

The same applies to hardware development. The middleware simplifies flexible integration into vehicles providing communications in one universal language. It translates and standardises the communication between the vehicles different hardware and software layers.

Depending on the OEM's software architecture, ZF offers a modular approach with its middleware from a full platform to single modules that can be integrated into the OEM's software. Thanks to its scalable ZF ProAI supercomputing platform, ZF can provide traditional and new users with software, computing and sensor hardware as well as connected actuators.

ZF is establishing a global software centre at the turn of the year.

"Our global software centre will be responsible for developing software for future architectures on a group-wide level and making them available to the entire company," said Walliser.

This will allow ZF to coordinate and standardise trends, technologies, methods, procedures, tools and functions to make the software available to all divisions on a common development platform.

In the medium term, this will lead to uniform structures and a uniform development environment throughout the group.

Renesas licenses Ceva DSP for SoC

Renesas has licensed a Ceva DSP to power its next automotive SoC.

"Automotive manufacturers are continually adopting more cameras, radars and other sensors throughout the car to ensure a safer and more automated driving experience," said Gideon Wertheizer, CEO of Ceva. "Our leading-edge DSPs along with our software framework and stringent safety support are set to play a pivotal role in deploying these complex systems."

The NeuPro-S and Sens-Pro have been licensed by multiple automotive semiconductors and OEMs to power intelligent processors for adas, battery management and powertrain platforms.

"In active safety and self-driving applications, DSP processing is a key IP for processing and segmenting sensor data generated by sensors on vehicles," said Naoki Yoshida, vice president at Renesas. "Ceva's automotive DSP helps us achieve the underlying processing capabilities."

POWER TECHNOLOGIES

ELECTRIFYING



Steve Rogerson explores how a close relationship between Analog Devices and car maker Rimac produced an electric supercar

Acceleration of 0 to 100km/hr in two seconds and a top speed of over 400km/hr would be impressive for any road car. But the C-Two from Croatian car maker Rimac is a full electric vehicle. The two-seater supercar also has a range of 550km.

Rimac was founded in 2009 by Mate Rimac, who had two years earlier attracted attention when he managed to install an electric powertrain in a BMW 3 Series. This led to investors coming on board to help him meet his vision of creating an all-electric sportscar.

After the first Concept One car in 2016, of which all eight were sold, in 2018 Porsche Engineering acquired a ten per cent stake.

The C-Two, first revealed as a concept at the 2018 Geneva Motor Show, has already sold all of the planned 150 production models, the first of which were due to be delivered in 2020 but that has been put back a year due to Covid-19.

Achieving the specifications mentioned earlier involves tight control of the battery system and this was helped following a partnership with Analog Devices, which is gearing much of its automotive business into electric vehicles.

"The market for electric vehicles has changed very rapidly over the past few years," said Greg Henderson, senior vice president at Analog Devices. "They've transitioned from a technology novelty with a sustainability benefit to being a true performance leader in the automotive market."

He added that EVs now had a lower total cost of ownership that those with an internal combustion engine.

But achieving the sorts of performance levels mentioned on top of the general trend for more computing power in vehicles for adas and future autonomous driving has meant that the car makers need to have a more intimate relationship with the technology providers, and that was illustrated with the C-Two that saw Analog Devices and Rimac collaborate closely on the battery technology.

"The Rimac engineers working with Analog Devices had to design the whole system from the ground up," said Henderson.

Patrick Morgan, vice president for automotive at Analog Devices, compared the current technology developments in automotive with what had happened in other sectors.

"The giant megatrend we had with mobile phones feels a lot like the journey we are on as a technology provider for the automotive industry," said Morgan. "The industry is changing. The landscape is changing very fast and it provides great opportunities to partner companies like Rimac. The future of automotive is electric."

Matija Gracin, director of components for R&D at Rimac, said that the company was working with firms such as Analog Devices because everything it did was performance driven.

He said the three key areas for EVs going forward were improving energy storage, improving efficiency and building an infrastructure to support growing numbers of EVs.

This does not just impact speed, acceleration and range but the



All of the planned 150 production models of the C-Two have been sold

whole driver and passenger experience.

"An electric vehicle is so quiet in the cabin, you can notice the road noise," said Morgan. "So we have technology to cancel out that noise. On range, people want more miles per charge. That is not just the battery but the electronics that control the battery. That is a high focus area for us. We have a shared vision with Rimac of electrification and performance underpinning that."

He said people spending time in their cars wanted an "excellent" experience. And with the electronics for the battery, these had to be accurate to extract every bit of charge.

But the story does not stop there. The batteries have a limited life powering a vehicle and they need to be recycled or, even better, reused in other energy storage applications.

"We are not doing enough at the moment," said Gracin. "Up to ninety per cent of the battery could be recycled and we could reuse it several times. There is a high demand from regulators on recycling. At least fifty per cent of the battery parts need to be recycled."

Using a wireless battery management system can help in recycling because it eliminates the wiring harness.

"Wireless battery management also lets the battery pack be designed in a modular, scalable way so that when you move into second life you are able to take these packs and match them for a specific application, and reconfigure them accordingly," said Morgan.

There is also a move towards zero-cobalt batteries and that means a battery management system needs to support a wide range of battery chemistries.

"Our technology supports that," said Morgan. "There are multiple chemistries being developed."

He said there were different use cases and that each battery had a chemistry component and electronics component and that helped determine how a battery could be used in second life.

"There is a need for really high accuracy in the vehicle," he said, "but that is not necessarily so in second life.

Another driver for electric vehicles has come from an unexpected side effect of the coronavirus pandemic. International lockdowns have reduced pollution in cities by amounts noticeable by the people who live in them and many are now keen not to return to the bad old days.

"For the first time in a long time in the Boston area, we can see the stars in the sky," said Morgan. "People are getting to know how clean air feels. It is giving a glimpse into the future of zero emission and people really appreciate it."

And now the technology has reached the point where players in the industry are confident there will be mass adoption of electric vehicles.

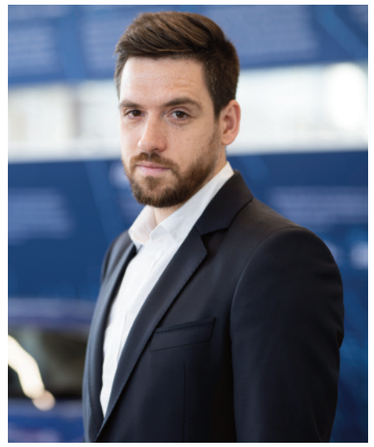
"We are seeing demand for electric vehicles really growing," said Gracin.



Greg Henderson: "The market for electric vehicles has changed very rapidly."



Patrick Morgan: "The future of automotive is electric."



Matija Gracin: "There is a high demand from regulators on recycling."

V2X

Testing, testing, testing



Holger Rosier and Christian Hof explain the importance of testing for a safe path to a successful C-V2X rollout

Over the past decades, the introduction of seat belts, airbags and vehicle crumple zones have made a massive contribution to saving lives on roads. Today's adas and future autonomous driving technology will go some way to driving down further the number of incidents on our highways, but they remain limited in their impact without access to the collective insights of all road users.

Even the most focused driver cannot react to an incident happening directly in front or obscured behind a blind bend. But, collectively, the companions on the road – drivers, cyclists and pedestrians – could share such insights with one another, allowing people to react accordingly and in time.

This is the vision that V2X communication offers the road users of tomorrow. Like all technologies, it requires standards to ensure everyone approaches the implementation in the same manner. However, who will be there to ensure the standards are met? And are there historical parallels that can provide suitable approaches?

Key to ensuring that automated and cooperative driving becomes reality, and the systems developed by different car manufactures and their suppliers are interoperable, are standards. Those for V2X communication are defined in a wide range of documents that cover everything from the access technologies up through to the facilities and applications layers.

Standards

Across the world, various standards for intelligent transport systems (ITS) have been developed. These range from the Wireless Access in Vehicular Environments (Wave) in the USA as defined in standards family IEEE 1609, and Etsi ITS-G5 in Europe. Both are based on IEEE 802.11p, an extension of the WLAN standard.

The 3rd Generation Partnership Project (3GPP) has worked, in parallel, on a worldwide communication layer standard that also enables ITS to operate over cellular network technologies, exploiting existing commercial mobile network technology. The device-to-device communication over this technology does not require any mobile network infrastructure.

The initial provisions, first introduced in release 12 in 2015, were further refined to support the needs of C-V2X with 3GPP release 14 in 2017, initially referred to as LTE V2X. In fact, the internet-of-vehicles as being implemented in China uses standards developed by several bodies, including the Society of Automotive Engineers of China, together with C-V2X.

Considered as a whole, C-V2X is an excellent technology for all road users, from pedestrian to powered, to share predefined messages on the status of our highways, with traffic infrastructure, and with other networks. Because it is built on the ubiquitous 4G LTE cellular technology already in use today, and because the 3GPP standards include a roadmap to the increased bandwidth and reduced latencies of future 5G networks, future compatibility is already built in. Furthermore, the necessary chipsets for radio communication and test equipment for proving interoperability are already in general circulation.

Here, an important distinction about C-V2X needs to be made. For the foreseeable future, a lot of

the communication will be based on 4G LTE. 5G support is around the corner and, as the network infrastructure is rolled out, some cellular vehicle-to-network (C-V2N) communications are likely to transition to 5G.

However, all other device-to-device functionality, such as vehicle-to-pedestrian, vehicle-to-vehicle and vehicle-to-infrastructure, will continue to require testing and approval against the existing 4G LTE standards for the foreseeable future.

What is also highlighted by the process that has created C-V2X is the tremendous amount of collaboration required to develop such standards. Some of the work has been supported by government grants for research into how best to approach the challenges of ITS. Organisations such as 3GPP also have their roots in collaboration, ensuring cellular handsets can operate globally.

And now, to ensure the automotive industry and the radio technology upon which C-V2X will rely meets everyone's needs, a new organisation has been formed.

The 5G Automotive Association (5GAA) is a cross-industry group of automotive players and representatives from the telecommunications industry. Since its inception it has established a global footprint of key industry representatives who ensure the necessary next stage of integration of automotive with telecommunications technology moves forward smoothly.

Its working groups examine a wide range of issues, from high-level topics such as business models and go-to-market strategies, to technical requirements and system architecture. They also undertake evaluations and promote large-scale trials, ensuring technical concepts have the opportunity to be tested in the cold reality of highways. This has resulted in a series of comprehensive white papers and studies providing in-depth insights into the technology underlying C-V2X.



C-V2X will help drivers know what is happening around them

Testing

Testing is an essential element for the launch of any product, and it accompanies the product from the research and development laboratory right through to end-of-line testing after manufacture. Obviously, one element of testing is to ensure the equipment operates within the limits as defined by the standards.

For a telecommunications device, this includes the RF stage along with the device's support for the various protocols it is designed to support. Over the years it is the software, and its ability to configure hardware test equipment quickly and easily to test a wide array of end equipment, that has become a key differentiating factor.

Perhaps just as critical is the software interface, or API, to that software, allowing designers to integrate the test and measurement hardware into larger test environments.

Testing of a static radio device on a laboratory bench can confirm conformity with the necessary telecommunication standards. However, this is of little use if, during use in the field under the harsh conditions of a vehicle's interior, full functionality cannot be assured. That is why some test equipment has been developed to operate within the context of field operation.

The interaction of a single C-V2X service with a reference system as defined by test equipment is, for sure, an essential benchmark test. However, there still remains the issue of interoperability. This is where it is valuable to consider the two-stage quality gate approach of the telecommunications industry. The worldwide success of the radio telecommunication standards developed by 3GPP can be assigned, in part, to the harmonised testing processes that take place.

Over the years, the Global Certification Forum (GCF) has established itself as the de facto arbitrator for conformity with the standards. The first stage entails testing handsets and modems independently for conformance with the relevant radio frequency and protocol standards. The second stage involves evaluation of the handsets as part of an operator carrier acceptance test.

This includes undertaking performance benchmarking and proving various network functions operate as expected. With the automobile essentially becoming connected and expected to operate seamlessly with other wireless nodes across national and international boundaries, consideration for such a testing procedure of C-V2X components and ECUs should surely also be undertaken.



Testing is essential for successful C-V2X deployments

The 5GAA is working to promote such a harmonised testing programme for C-V2X. As for the telecommunications industry, this could be split into a physical layer conformance test for the RF layer and interoperability testing for the layers above. Such an approach could include harmonised test procedures, a set of minimum requirements and selection of suitable test partners. The physical layer would necessarily require conformance with worldwide standards, while the upper layers would be tested against regional standards, most likely split into EU, US and China regions.

Conclusion

C-V2X has the potential to improve safety significantly for pedestrians and transportation technology alike. The standards organisations, boards, panels and advisory committees that contribute to the necessary technologies are indicative of the vision for achieving zero accidents on roads and highways. As ITS and C-V2X move from concept to reality, there will be more unique insights, learning and experience to bridge the worlds of the automotive and telecommunication industries to the benefit of all road users.





Holger Rosier is wireless technology manager and Christian Hof is product manager for Rohde & Schwarz



FROM AFAR

Steve Whelan suggests why it will be the early adopters of virtual testing who will reap the benefits

For some time, automotive industry giants have pointed towards a future of increased virtual testing as a way for car manufacturers to optimise efficiencies drastically and, in turn, reduce the high costs typically associated with physically testing vehicles and associated infrastructure.

With the restrictions of the Covid-19 pandemic affecting manufacturers and suppliers worldwide, this once distant prospect has quickly turned into a reality for many. And for those that have now gained a first-hand experience of the multiple benefits afforded by the virtualisation of testing, it may come as no surprise that this approach looks likely fast to become the new normal.

The introduction of real driving emissions (RDE) in 2017 marked a new era for measuring the fuel economy and emissions of vehicles whereby, for the time, manufacturers became required to prove their emissions credentials under real and random driving conditions. This resulted in a threefold increase in the time taken to test vehicle emissions amid the associated complexities of real-life, physical testing.

Fast forward to 2021 and the adoption of even tougher RDE margins will place even greater pressure on OEMs. To put this into context, the current margin for error during road tests sits at 2.1, meaning a test may exceed the measured emission value by a maximum of 2.1 times.

By 2021, however, this figure will drop to just 1.43, followed by a further expected decrease to 1.0 by 2025, making it more important for manufacturers to ensure the greatest level of accuracy at all times.

All this is happening at a time when OEMs face mounting pressure to adopt complex new technologies, driving product development complexity and, in some cases, cost to unsustainable levels.

Conventional

Traditionally, RDE testing is performed through the use of a portable emissions measuring system (PEMS) mounted to the rear of the vehicle. Bringing together data and instrumentation, a PEMS enables certification of vehicle emissions in real-world driving, as they are affected by local weather, altitude, driving style and traffic conditions. Thus, it offers complete and real-time monitoring of the key pollutants emitted by engines in real-world environments.

However, this method is not without its drawbacks. A PEMS lacks the measurement accuracy provided by specialist laboratory equipment.

The real-world element of the RDE process introduces an infinite number of scenarios that can consume months of development time. Testing in the necessary conditions typically requires engineering teams to travel to different locations, where they can remain on-site for weeks to setup the vehicle and even longer to achieve successful testing results.

In fact, research with OEMs suggests the challenges associated with achieving confidence the vehicle will comply with all probable RDE conditions has extended testing timelines by two to three times. And, as the automotive industry continues to go through a huge period of transformation, this method is becoming unsustainable.

OEMs are developing, integrating and launching complex technologies faster than ever. Autonomous driving aids and the electrification of vehicles are changing the way in which vehicles are used. Product variety has exploded, with more vehicle segments and configuration choices.

These trends, together with more stringent emissions standards, have increased the complexity of product development tenfold. It is clear that alternative testing and development methods are needed; change is required.

Virtual

Automotive manufacturers have recognised they need to replicate the agility of industries such as IT, where flexible product development processes have led to reduced lead times, increased quality and enhanced customer satisfaction. And one viable answer comes in the form of virtualisation; using sophisticated modelling and simulation capabilities to accelerate the engineering design and development process.

For automotive OEMs, using virtualisation technologies enables the evaluation and development of systems and settings within a virtual domain where time can be accelerated and changes can be made within computer models and not in the workshop.

The result is the ability to test and evaluate many more design permutations under many more



Virtualising RDE testing could help automotive OEMs reduce their prototype vehicle requirements up to 75%

scenarios in much shorter timeframes – and more quickly, given this approach can be done faster than real-time round the clock and does not rely on the limitations of the real world.

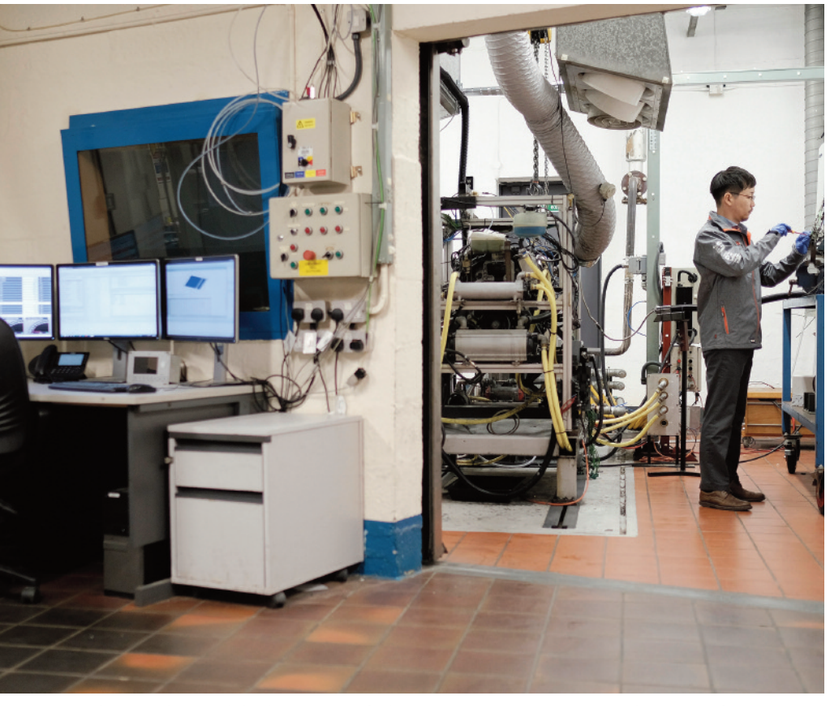
The only drawback here is the accuracy and reliability of the models. However, this can be mitigated by integrating critical hardware elements into the virtual network, which is known as hardware-in-the-loop (HiL).

Here, an engine can be installed in a test cell and connected to a model of a vehicle and the environment whereby the virtual vehicle can be driven through the virtual environment with the real engine running synchronously. This enables real emissions and performance attributes to be developed in a vehicle that has yet to leave the CAD system, or the drawing board even. The result is the best of both worlds, virtual and physical.

In this way, manufacturers can test designs quickly and easily at every stage of the design process to ensure compliance, thereby reducing prototype programme costs and the risk of non-compliance near to market launch, all this with unparalleled accuracy and control.

Virtualising RDE testing could help automotive OEMs reduce their prototype vehicle requirements up to 75% by replacing on-road testing with more efficient development in the laboratory, resulting in savings of up to £14m per vehicle programme. This is in addition to huge potential savings in reduced testing and development times.

It is easy to see why manufacturers were already switched onto the benefits of virtual RDE testing.



The real-world element of the RDE process introduces infinite scenarios that can consume months of development time

Automated

Already, highly intelligent systems can run tests automatically with little and remote human interaction. Engineers and technicians can schedule, execute and interrogate any number of tests from their home office or kitchen table, whenever and wherever they are in the world.

Inherently, this approach offers huge benefits for busy OEMs in enabling global R&D teams to work fluidly together from multiple locations, negating expensive travel and logistical challenges, and ultimately increasing efficiencies, lead times and profitability.

Add to the equation the impact of Covid-19, and this demand for remote automated testing has, of course, accelerated in helping deliver continued and enhanced testing productivity during the pandemic when human support has been compromised. Thus, the inevitable and logical next step has been to combine remote and virtual testing methods to ensure the optimal setup in terms of improved accuracy, efficiencies and potentially huge cost reductions.

Revolution

With this in mind, OEMs are now turning their attention to sourcing an effective, reliable method for virtualised and remote RDE testing. This includes innovations that consist of an integrated toolbox that enables a virtual and road-to-laboratory approach.



OEMs are turning their attention to sourcing effective, reliable virtualised and remote RDE testing

This brings together established hardware and software, interfaced with standard virtual tools such as vehicle simulation and environment simulation, to enable physical testing to be controlled by virtual modelling. It means quicker and more accurate virtual and HiL testing.

Such technology and testing methods must be used at this pivotal time for the global automotive industry as it seeks to meet the future technology challenge while recovering from the impact of Covid-19.

In supporting the transition to a more agile approach, it enables OEMS to meet future vehicle demand more quickly, with greater accuracy and with significantly lower development costs. It provides greater confidence and reduces risk, all crucial factors that help ensure the commercial viability of product development in the current automotive sector.

Forwards

With imminent enforcement of tougher real world and in-service emissions limitations, it is inevitable that the benefits offered by virtualisation will only offer greater significance in the coming months and years. With more stringent requirements comes greater need for accuracy, not to mention the continued uncertainty over global travel and increased complexity of product development.

Undoubtedly, virtual RDE testing removes one of the main pressure points on OEMS during what remains one of the most challenging periods in history for the industry.

Covid-19 may have accelerated the shift to more efficient testing, but it was an inevitable development, particularly with the continued advancement of technology.

For those seeking to keep in the fast lane and stay competitive during this turbulent time, then surely it's time to go virtual.



Steve Whelan is global development and application centre leader at Horiba

HOPE OR HYPE?

Simone Bruckner investigates the pros and cons of hydrogen for the automotive industry

Hyundai Nexo hydrogen vehicle

As funding initiatives are rolled out for energy efficiency and electric vehicles (EVs), how does hydrogen compare with other green energy alternatives?

At the dawn of the 21st century, backers of hydrogen had high hopes that the technology would dominate the automotive market. This has yet to happen, although hydrogen appears to have found its way back into the frame in recent years; Hyundai, Toyota and Honda have each produced hydrogen cars that are publicly available in select markets.

Such developments of hydrogen vehicles give hope to the idea that hydrogen will one day dominate the market. For now, it seems that competing battery electric vehicle (BEV) technologies have taken pole position as the technology that could remove fossil fuels from roads. Why is hydrogen falling behind alternatives such as BEVs?



Is it hydrogen or are electric vehicles at the heart of the green transport revolution?

Clean

To power vehicles, energy-dense hydrogen can be stored in a fuel cell, which converts energy stored in molecules into electrical energy. By using hydrogen and oxygen as power, the fuel cell produces water, electricity and heat, without creating any emissions, other than water vapour.

Hydrogen fuel offers many benefits. In terms of range – the distance a vehicle can travel without refuelling – current hydrogen models fair slightly better than BEV alternatives. Consumer uptake could also be more promising; it has been reported that just one-in-four are considering the purchase of a fully EV in the next five years.

Certain advantages of hydrogen could overcome this consumer reluctance. Future hydrogen vehicles will only need to adjust to using a different kind of gas. Also, hydrogen refuelling times are comparable to fossil fuel powered cars, which should alleviate consumers' anxieties over the technology's range and a need for frequent charging stops.

As with all new technologies, there remain some barriers to hydrogen adoption.

One obstacle to the widespread adoption of hydrogen fuel cells is that the technology requires an entirely new charging infrastructure. BEVs, on the other hand, can simply be charged off the electricity grid. The high-powered batteries found in BEVs are also informed by the advanced battery technologies found in applications such as computers, which can be easily adapted and developed.

Another issue that throws hydrogen readiness into question is the current price point of hydrogen vehicles. Paired with the needed infrastructural developments, the future could be hydrogen, but it is certainly not the present.

What are the other downsides of hydrogen? Water-only emissions may seem like a green alternative, but the technology's sustainability still poses problems. Currently. almost all the hydrogen sold is produced by splitting it from natural gas, which is costly and emits a lot of carbon dioxide (CO_2).

However, this problem can be tackled by capturing the CO_2 during hydrogen production, then burying it with carbon capture and storage. But that will drive up costs. The alternative entails using surplus renewable electricity to split hydrogen from water using a fuel cell, which is cleaner but more expensive.



Hydrogen refuelling times and procedures are similar to fossil fuel powered cars

Electric dream?

As with hydrogen fuel cells, there is some consumer reluctance towards BEVs, yet uptake is on the rise.

The UK's market, for example, grew 21 per cent in 2019 with the joint government and car industry campaign, Go Ultra Low, recording more than 72,000 new electric car registrations that year; a new record.

BEVs offer their own set of benefits. Electric motors can deliver torque quickly with almost instant acceleration, making vehicles quicker to start. Charging infrastructure is also far more developed than hydrogen refuelling capabilities.

As BEV uptake increases, with a robust charging infrastructure already in place, it will be wise to continue investing in EV technologies at the same time as driving forward with hydrogen technology.

Components

In addition to battery technology, resistors also play an important role in EV efficiency.

Most EVs use regenerative braking, which recuperates energy lost through braking and returns it to the battery to increase the range. However, when the battery is full, the vehicle must rely on its mechanical friction braking system to slow the vehicle.

Instead, it is more beneficial to use a resistor to discharge the excess energy. Not only is the resistor useful in the event of an electrical fault, it also reduces servicing costs due to reduced wear on the friction braking system.

The energy dissipated during dynamic braking into the resistor can also heat the vehicle's cabin, reducing the requirement for electrical heating, which places an extra load on the battery.

Conclusion

The hydrogen revolution is arriving, with government backing sure to boost its uptake. However, much has still to be done to make hydrogen a commercially viable fuel.

While looking forward to the benefits of hydrogen, competing technologies such as BEVs, paired with other high-tech components such as advanced resistors, can continue to drive the automotive industry's green revolution forward.



Simone Bruckner is managing director of Cressall

WHAT, WHEN AND HOW?

Matteo Crosio compares A²B and Ethernet for automotive applications

The number of electronic systems in cars has increased in recent years, reaching higher levels of complexity with the adoption of new technologies for infotainment and adas – cameras, radar, lidar and so on – along with multiple sensors for many different purposes, such as stability, speed and acceleration.

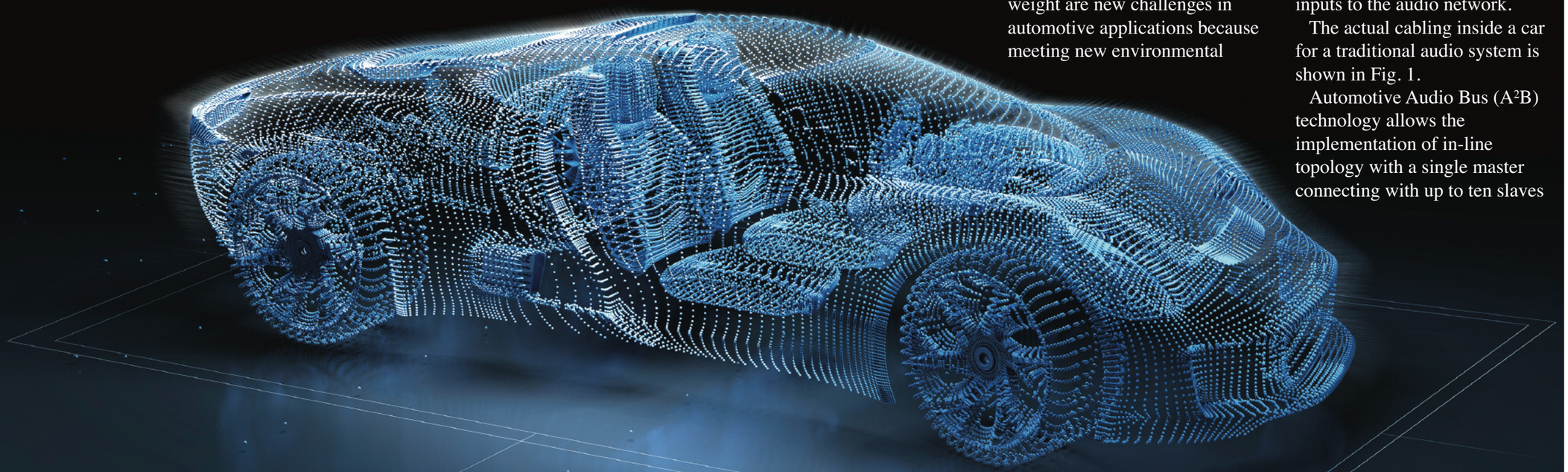
Typically, sensors require a low bandwidth. The most common accelerometers in cars have an output data rate (ODR) of a few kHz. When it comes to infotainment, audio and video data require a data rate in the range of several Mbit/s.

However, what is really raising the bar is the adoption of HD multi-camera systems for parking assistance, 360˚ vision systems also known as bird's-eye view or surround view monitor systems, radar (RF microwave) and lidar to enhance adas. The coexistence of all these systems is a key factor in the development of autonomous vehicles, but it represents a big challenge for any communication bus.

Traditional buses used in automotive are:

- **Lin:** With a speed of up to 20kbit/s, it is mainly used within subsystems where low cost is essential and the speed to bandwidth ratio is not important.
- **Can:** With a transmission rate of up to 1Mbit/s, it is mainly used for communication between the ECU and sensors in start-stop systems, parking assist and electric park brakes.
- **Flexray:** Faster than Can (up to 10Mbit/ps), it is more expensive. It was initially adopted for x-by-wire (drive-by-wire, steer-by-wire) systems and conceived to accommodate multiple network topologies.
- **Most:** With a maximum speed of 150Mbit/s, it is designed to transport audio, video, voice and data signals. It defines all seven layers of the ISO/OSI model, from the physical level up to the application layer. It is proprietary.

With such evolution in network technology, another aspect has become important. Many different buses used for different subsystems include very complex and expensive cabling. Size and weight are new challenges in automotive applications because meeting new environmental regulations means developing systems that can, for example, reduce CO_2 emissions. In such a landscape there's no easy answer to the need for a high bandwidth, low latency, deterministic, robust and cheap communication bus.



Automotive Audio Bus

One of the major contributions to the total cabling weight comes from car audio systems because analogue wiring requires expensive shielded cables for each audio source-sink (loudspeaker). Moreover, active noise cancellation (ANC) and road noise cancellation (RNC) require several microphones inside the car, adding many other inputs to the audio network.

The actual cabling inside a car for a traditional audio system is shown in Fig. 1.

Automotive Audio Bus (A²B) technology allows the implementation of in-line topology with a single master connecting with up to ten slaves daisy chained. With a speed of 50Mbit/s, A²B is optimised for audio applications.

Connectivity is simplified by using an unshielded twisted pair (UTP) cable, reducing the total weight of the harness by up to 75%. The distance between nodes can be as long as 15m, while the maximum network length is 40m. The same UTP supplies power (phantom powered configuration) up to 300mA, suitable for digital microphones.

It is always possible to provide slave nodes with a local power supply, in case the power budget provided by the master is insufficient. The bus allows a bidirectional, master-to-slave and slave-to-slave communication, bringing up to 32 channels downstream and upstream, 12, 16 and 24bit. Most importantly, a two-cycle latency is guaranteed, providing latency-sensitive applications such as ANC and RNC with a deterministic support. The bus can transport I²C messages, allowing the configuration over distance of ADCs and DACs at slave nodes.

Typically, an I²S interface is used for connecting to ADCs and DACs, while digital microphones use PDM.

One of the major concerns in automotive applications is related to electromagnetic compatibility (EMC). A²B has passed stringent automotive EMC and EMI compatibility tests using just a two-wire UTP cable. RNC applications require accelerometers and microphones distributed around and inside the vehicle.

The use of analogue parts is cost-prohibitive as it would

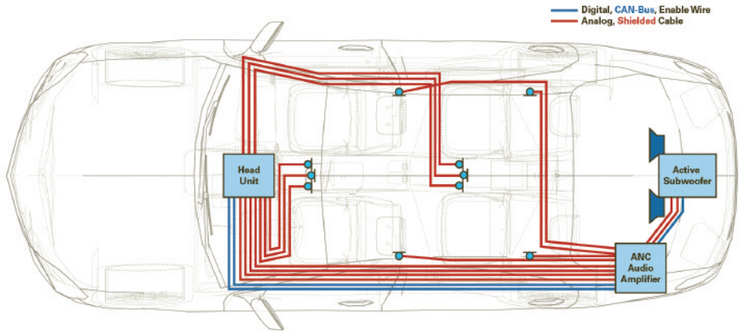


Fig. 1: Traditional in-car cabling for audio systems

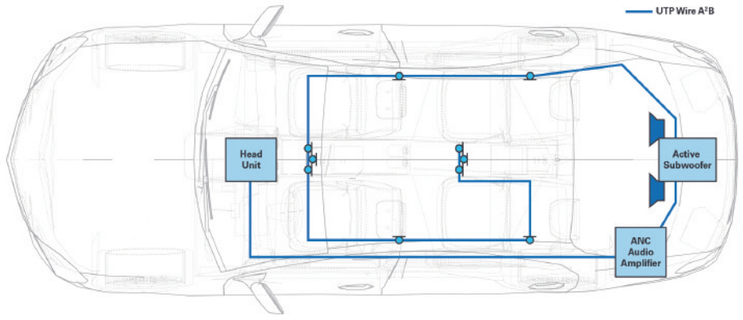


Fig. 2: In-car cabling for audio simplified by A²B technology

require additional circuitry such as ADCs, wiring and connectors. The A²B technology simplifies this architecture with a novel approach to audio sources and sensors.

Ethernet

Ethernet is a popular networking technology and possesses a large ecosystem. However, its use in the automotive field is limited so far to a few applications such as diagnostics, in-vehicle infotainment and connectivity to sensors. Its rival for in-car applications is likely Most, which can compete in terms of speed.

Although Ethernet has the potential to become the definitive answer to the huge demand for bandwidth arising with the latest technologies such as radar and lidar, there are several aspects still limiting its adoption in cars.

Traditional Ethernet cables used for 100baseTX, based on two differential pair wires and isolated by transformers, are too expensive for automotive applications. Moreover, a Cat-5 cable doesn't meet automotive EMI standards, making the 100baseTX Ethernet useless for in-car communications other than diagnostics and firmware updates.

For vehicle-to-vehicle (V2V) or vehicle-to-everything (V2X) communications, in-car data transport must be supported in terms of synchronisation, traffic shaping and fixed latency. Ethernet doesn't have this kind of support, unless new protocol stacks are implemented.

Let's consider the physical layer first.

With the aim of meeting the requirements in terms of weight, EMI and cost, the IEEE defined a standard called 802.3bw, also known as 100baseT1. IEEE 802.3bw is a 100Mbit/s standard based on a UTP cable that is bidirectional and that meets strong automotive emissions requirements. EMI is reduced by using the basic principles of superposition, specific encoding and scrambling schemes.

Weight and cost are lower when an unshielded two-wire cable is used instead of the traditional Cat-5 cable. Technologies such as power over Ethernet (PoE) provide power along with data, sharing the same wires. However, PoE requires at least two pairs of wires for providing power, clearly in contrast with the need to reduce the number of wires.

This is why IEEE defined the standard 802.3bu, also known as power over data lines (PoDL). PoDL can provide power over a single pair of wires, adding some complexity to the transceiver schematics. See Fig. 3.

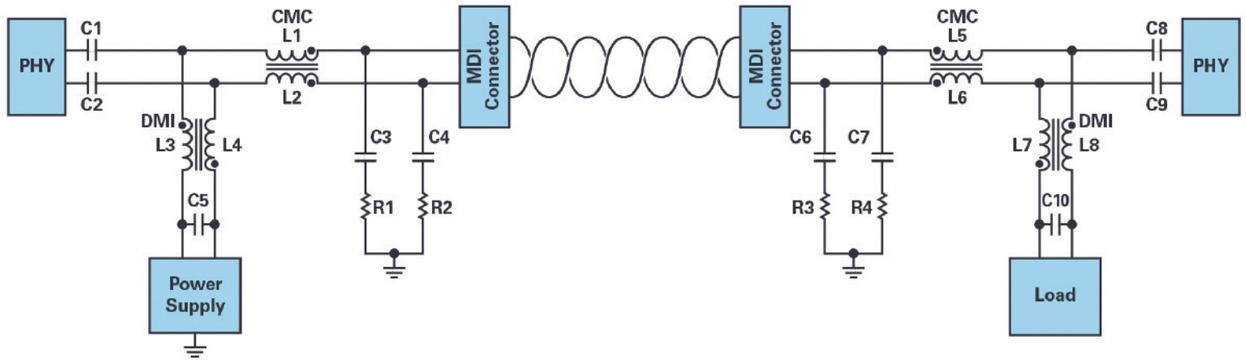


Fig. 3: Basic PoDL architecture: data and power share the same differential channel

As stated, to support automotive applications, Ethernet needs additional SW providing determinism. This can be achieved by the Audio Video Bridging (AVB) protocol, developed within the IEEE 802.1, the organisation in charge of the second layer in the ISO/OSI model.

AVB is a SW technology providing time synchronisation and traffic shaping. With these fundamental concepts, Ethernet can bring audio and video content reliably. AVB led to the definition of a set of protocols known as time-sensitive networking (TSN), focused on the industrial and automotive markets, providing Ethernet with real-time support.

To summarise, IEEE 802.3bw plus TSN can be suitable for deterministic communication within a car, replacing traditional buses. Moreover, 100baseT1 is evolving to a new 1000baseT1 standard that can reach 1Gbit/s. However, such systems are complex, and these technologies are not mature enough for wide deployment within the automotive market.

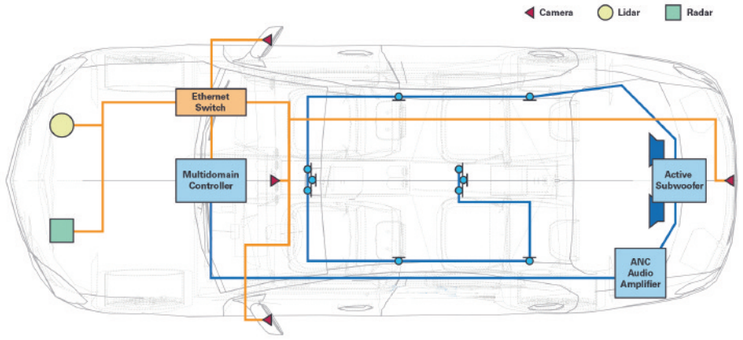


Fig. 4: Multi-domain architecture

Possible scenarios

While the automotive market is starting to adopt A²B for audio transport in cars, Ethernet is still far from massive implementation when it comes to conveying data from different bus systems.

Applications such as ANC, hands-free systems, noise generation for electric vehicles (EVs) and emergency call (ecall) systems benefit from the simplification introduced by A²B technology. Moreover, in the future, it could be possible to bring the information from digital sensors directly to the A²B, simplifying the architecture of RNC systems.

However, A²B has a limitation in bandwidth related to the bus speed. Ethernet could reach the speed of 1Gbit/s once the 1000baseT1 matures; with this bandwidth it could easily bring different kinds of data, from sensors to audio-video streams.

Autonomous driving is pushing for even further performances, heading to multigigabit network connectivity. So, which kind of scenario should be expected for the next few years?

A²B is an easy to implement technology, bringing power and data over the same UTP, with a deterministic support for fixed latency.

Ethernet, with the incumbent 100baseT1, and 1000baseT1 in the future, will be a convergent technology allowing the aggregation of multiple data buses, but with an increased complexity for adding power (PoDL) and SW determinism (TSN).

Likely, a mixture based on A²B for audio transport and sensors, and a backbone implemented with a high-speed Gigabit Ethernet for cameras, lidar and radar, could fit most of the future mid-term needs of the automotive industry.



Matteo Crosio is a field applications engineer at Analog Devices

MCUs transmit and receive data through Can-FD bus

Meeting the demand for increased bandwidth and flexible data rates in evolving automotive applications such as safety and communication, while supporting the development of adas, Microchip has announced its Pic 18 Q84 family.

This is the first Pic 18 microcontroller family that can be used to transmit and receive data through a Can-FD bus.

Accompanied by an array of core independent peripherals (CIPs) that handle tasks without requiring CPU intervention, the family can cut time and cost when connecting to a Can-FD network.



The family provides a simple way to transport sensor data to a Can-FD bus, without the need for gateways or sophisticated network switching techniques. In addition, its configurable CIPs make it easy to create custom hardware-based functions for automotive and industrial designs with near-zero latency. Additional code is not required.

Available peripherals include a 32bit cyclic redundancy check with scan and a windowed watchdog timer for functional safety capabilities. A JTag interface can be used for standard testing and debugging.

There is hardware and software support.

Hardware includes a Curiosity nano development board and Curiosity high pin count development board. A plug-in module is available for the automotive networking development board and for use with Microchip development boards.

The software includes Microchip's MPLab code configurator.

The company also provides Can-FD transceivers and controllers.

Embedded storage meets AEC-Q100

Automotive grade eMMC products from Longsys have passed AEC-Q100 grade-three certification.

The Foresee devices are available in 8, 16, 32 and 64Gbyte capacities with an operating range of -40 to +85˚C.

They come with technical support services, three-year warranty and more than three-year supply guarantee.

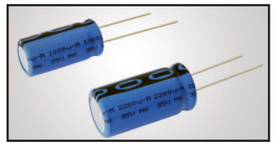
The range also includes industrial-grade and industrial wide-temperature eMMCs.

The industrial-grade devices use firmware developed by Longsys. They are available in 16, 32, 64 and 128Gbyte and operate from -25 to +85˚C.

They are designed with a service life of ten years.

The wide-temperature products come in 8, 16, 32, 64 and 128Gbyte capacities with an operating range of -40 to +85˚C. They can be used in automotive, industrial automation, safety protection and IT-based emergency response fields.





Aluminium caps

Low impedance, automotive grade miniature aluminium electrolytic capacitors from Vishay combine ripple currents up to 3.8A with temperature operation to +105˚C and useful life up to 10,000 hours at +105˚C.

Compared with the previous generation, the BC Components 170 RVZ capacitors have lower impedance and 10 to 15% higher ripple current, at 445 to 3800mA. This lets designers use fewer components, increasing design flexibility and saving board space.

The AEC-Q200 qualified devices are available in case sizes from 10 by 12mm to 18 by 40mm.

Featuring radial leads and a cylindrical aluminium case, insulated with a blue sleeve, they have rated voltages up to 63V, capacitance from 100 to 6800μF, and low impedance. They are charge and discharge proof.

As polarised aluminium electrolytic capacitors with a non-solid electrolyte, the RoHS-compliant devices are suitable for smoothing, filtering and buffering in switch mode power supplies and DC-DC converters.

Asil D SoC targets adas and automated driving

An Asil D SoC from Renesas is for adas and automated driving (AD) applications.

The R-Car V3U delivers 60Tops and up to 96,000DMips.

This is the first SoC using the R-Car gen-four architecture within the firm's open and flexible autonomy platform for adas. The platform is ready to offer scalability from entry-level NCap applications up to highly automated driving.

The SoC integrates multiple safety mechanisms that provide high coverage with fast detection and response for random hardware faults, and is expected to achieve Asil D metrics for most of the SoC processing chain.

It delivers flexible DNN (deep neural network) and AI machine-learning functions. Its flexible architecture can handle neural networks for automotive obstacle detection and classification tasks while maintaining 60Tops with low power consumption and an air-cooling system.

Programmable engines include DSP for radar processing, multi-threading computer vision engine for traditional computer vision algorithms, image signal processing to enhance image quality, and hardware accelerators for algorithms such as dense optical flow, stereo disparity and object classification.



An open and integrated development environment enables users to take advantage of the platform's built-in hardware, as well as low power consumption and deterministic real-time software.

Debugging and tuning tools for heterogeneous multi-core hardware enable software development while example applications and online education resources help engineers jumpstart their design process.

Qualified compilers and code generators for compliance with functional safety and cyber-security requirements enable the development of safe and secure software.

The R-Car V3U can be combines with the firm's low-power RH850 microcontroller, integrated power management ICs and power transistor devices to access components for adas and AD ECUs.

Samples are available now. Mass production is planned for the second quarter of 2023.

Secure flash memory meets Asil D

Winbond Electronics' W75F secure flash memory device with Common Criteria EAL5+ certificate has achieved ISO 26262 Asil D safety certification.

For automotive, the memory complies with AEC-Q100 and provides fault detection covering more than 99.9% of failures from flash array cells, through the physical interface, and all the way to the host.

The safety rating surpasses that of internal embedded flash memories while offering more storage that can be scaled up to higher densities.

It has also been certified with the Security Evaluation Scheme for IoT Platforms (SESIP) scheme for IoT and smart connected devices up to level three with physical attacker.

For code and data storage, it can help defend products against threats such as replay, rollback, man-in-the-middle, sniffing, side-channel and fault injection attacks.

It is available in densities of 4, 16 and 32Mbit and comes in sop-16, QFN32 and WLCSP packages.

Radar sensors surround vehicles in safety cocoon

Radar sensor chipsets from NXP can surround vehicles in a 360˚ safety cocoon and enable the identification and classification capabilities of imaging radar.

The radar processors and 77GHz transceivers provide scalable configurations that address NCap requirements for corner and front radar applications while offering 4D imaging radar, which expands radar's capabilities from measuring range and speed to include direction, angle of arrival and elevation measurement.



The radar sensors suit adas applications driving levels one to three and for robotaxi and delivery applications for levels four and five automation.

Imaging radar delivers multi-modal capabilities and extends level-two features, such as highway pilot and lane change assistance, with better resolution images for environmental mapping and scene understanding. This is important for enabling full autonomy.

The combination of the purpose-built S32R45 radar processor and the TEF82xx transceivers delivers the angular resolution, processing power and range required to distinguish between small objects in the distance and accurately separate and classify vehicles and vulnerable road users such as cyclists or pedestrians in crowded environments.

The radar sensors are built on volume-proven 16nm FinFet and 40nm RF cmos technology.

They are sampling with customers and will be available in mass production during 2021.

Radar-on-chip

A production-ready radar-on-chip (RoC) from Vayyar is AEC-Q100 qualified.

The chip has up to 48 transceivers, an internal DSP and MCU for real-time signal processing. Capable of seeing through objects and able to operate in all weather conditions, it can replace more than a dozen other sensors and negates the need for lidar and cameras.



Within the cabin, one chip can support various systems, including intruder alerts, child presence detection, seat belt reminders and ecall.

It fulfils the functions of multiple chips by sensing, computing, processing, mapping and imaging targets with a single radio-frequency IC.

The sensor is engineered for scalability, facilitating the deployment of emerging features via over-the-air software updates.

Current sensors

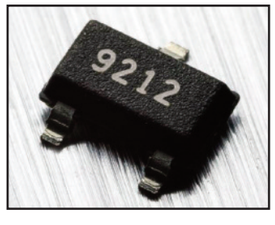
Two variants of a Hall-effect current-sensing IC from Melexis provide a choice of features for applications such as belt-driven starter generators and traction inverters for low-speed electric vehicles and e-scooters.

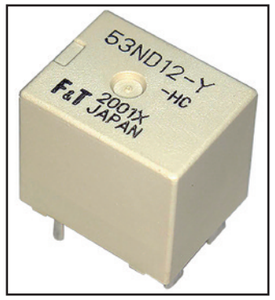
Combined with a ferromagnetic core, the non-intrusive sensors generate an analogue output proportional to the current flowing in the cable or bus bar. The output has a 40kHz bandwidth and the sensor a step response time below 10μs.

The MLX91211LUA-ABT is factory-calibrated at three temperature points enabling increased accuracy for motor control. The cheaper MLX-91211LUA-ABA addresses applications that have lower bandwidth and lower accuracy requirements.

Sensitivity thermal drift is better than 1.5%.

Both are qualified to AEC-Q100 grade 0, covering ambient temperatures from -40 to +150˚C for automotive use.





PCB relay

Fujitsu has expanded its automotive relay offering with a 12V DC PCB relay featuring a switching capacity of 50A at 14V DC.

The FBR53-HC has a higher contact rating than its 40A FBR53-HW counterpart, yet occupies the same 12.1 by 15.5 by 13.7mm footprint and weighs the same 6g.

With a maximum carrying current of 62.5A, 14V DC (30 minutes at +125˚C) and an operating temperature of -40 to +125˚C, the relay suits medium-to-heavy loads, such as electric power steering, radiator fans, fuel pumps, seat heaters, head lamps and motor braking circuits.

The mini ISO relay replacement employs a 1-Form U dual contact arrangement normally open. It has a typical electrical life of 100,000 operations and power consumption of 600mW.

The RoHS-compliant relay comes in a plastic sealed package and is also available in a through-hole reflow version.

Development boards speed design

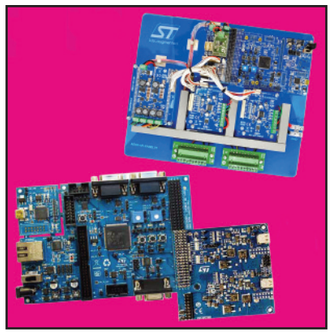
ST Microelectronics is supporting the accelerated design of automotive systems and similar projects in robotics, automation and other industrial applications with a suite of development boards.

The AutoDevKit fast prototyping development ecosystem was developed to address the automotive and transportation market and is finding uses in industrial equipment. It provides engineers with quick evaluation and rapid prototyping in a common, integrated and flexible environment supporting complete ECU-like development.

Available from distributor Anglia, the kit gives engineers the flexibility to mix and match components to create quick prototypes and consists of a suite of functional boards covering applications such as LED lighting, power management, sensing, audio, connectivity and communications.

After choosing the preferred components, users are guided to connect the boards, generate code, compile and download firmware, without forgetting prototype testing and debugging. A fundamental aspect of the ecosystem is to offer easy-to-use APIs for communication and control for each of the functional boards supported.

AutoDevKit is an Eclipse plug-in running under the SPC5 Studio integrated development environment. It is supported by a free library, a software environment that lets users select the microcontrollers and functional boards from STM.



In-vehicle system quickens development

An in-vehicle system from Via Technologies can speed time to market for self-driving and vehicle safety developments.

The Mobile 360 L900 is a platform for prototyping and mass production.

It delivers compute, graphics and AI performance with its integrated Nvidia Jetson TX2 module with dual-core Denver 2 64bit CPU, Arm Cortex-A57 MPCore, and 256-core Nvidia Pascal GPU architecture with 256 Nvidia Cuda cores.

The aluminium chassis lets it be used in on-road and off-road conditions

Aimed at start-ups and developers, it speeds development time for autonomous vehicle, driver assistance and operator safety applications. The nine automotive-grade cameras provide flexibility for integrating adas, surround view and driver monitoring features.



IO includes nine Fakra connectors, HDMI port, two USB 3.0 ports, Can bus port, DIO and Com ports, and a Micro SD slot. This allows flexible integration of cameras, displays, storage, sensors and peripherals.

Connectivity is enabled by wifi, GPS and BT 4.1 plus a Gigabit Ethernet port and sim card slot.

ESD devices provide protection for Can-FD

Leadless ESD protection devices from Nexperia are for Can-FD applications.

The devices are available in leadless packages with side-wettable flanks that let automatic optical inspection (AOI) tools be used.

AEC-Q101-qualified, the PESD2Can-FDx parts have claimed industry-leading ESD and RF performance, and save PCB space.

The silicon-based ESD protection devices come in both leaded and leadless packages.

The DFN1412D-3 and DFN1110D-3 leadless DFN packages with side-wettable flanks occupy 80% less PCB space than traditional sot-23 and sot-323 packages.

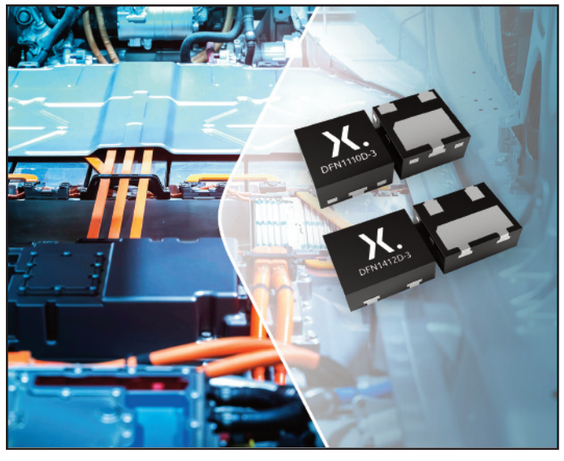
Despite this, products assembled in this package have improved thermal behaviour due to a larger internal lead frame that includes a heatsink and thermal pad.

The diodes are also ESD robust delivering system level protection. This is because the parts have clamping voltages of 33V at I_{PP} of 1A and dynamic resistance of 0.7Ω.

RF switching parameters feature a mixed mode insertion loss of +20dB at 300MHz.

Can-FD is an important bus in automotive in-vehicle networks but devices must be protected against ESD. And they must use AOI. These devices in leadless packages meet both these requirements, providing an alternative to leaded SMD packages.

They exceed the requirements of AEC-Q101 by two times.





DC-DC converters target adas

Twelve automotive primary DC-DC converters from Rohm are optimised for adas sensors, cameras and radar, along with car infotainment and instrument clusters.

With conventional power supply ICs, it is difficult to achieve both fast load responses to ensure stable operation and high efficiency in power conversion, contributing to greater energy savings.

The BD9P series uses nano pulse control power supply technology to enable operation at 2.2MHz that will not interfere with the AM radio band (1.84MHz maximum) while achieving high step-down ratio.

The devices ensure stable operation during battery input voltage fluctuation, reducing output overshoot to less than a tenth of conventional products. This eliminates the need for additional output capacitors typically required to reduce overshoot voltages.

The control method makes it possible to achieve high efficiency and fast load response, which are in a trade-off relationship.

The DC-DC converters have a 92% power conversion efficiency at heavy loads at 1A output current, and 85% efficiency at light loads (1mA). This reduces power consumption, which leads to a reduction in CO_2 emissions, and the parasitic discharge of the battery is also reduced.

Combining the product with the BD9S series of secondary DC-DC converters cascaded to the subsequent stage can help users configure faster, more efficient automotive power supply circuits.

Reference designs are available. Using reference boards, tools and Rohm's free web simulation tool, it is possible to perform simulations close to actual conditions, reducing application design resources.

Buck converters come with power-good indicator

Automotive-compliant synchronous buck converters from Diodes feature noise reduction and a power-good indicator.

The converters can simplify circuit design in automotive power systems with the power-good output and EMI mitigation for noise-sensitive applications.

The AP63356Q and AP63357Q are 3.5A converters with an input voltage of 3.8 to 32V. Leveraging peak current mode control as well as high-side and low-side power mosfets on-chip, the converters can reduce external components to lower costs and shrink board size.

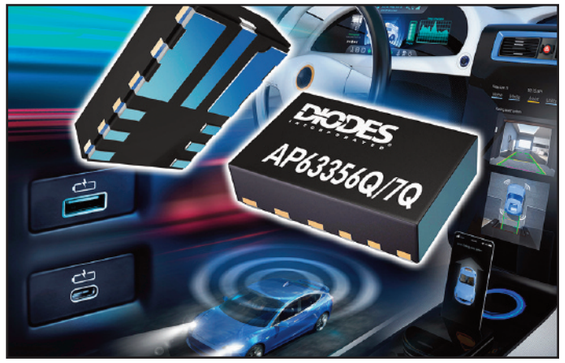
Both have a power-good indicator with an internal 5MΩ pull-up resistor for power sequencing. To aid sequencing, their enable pin has accurate voltage thresholds, which allows adjustment of the input voltage device power-on and under-voltage lockout.

The high-voltage capability of the EN pin allows direct connection to V_{IN} to simplify the auto-start of the device. When disabled, the converter draws 0.6μA shutdown current typical.

Their proprietary gate-driver scheme ensures clean switching transitions while preventing switch-node ringing to reduce high-frequency radiated noise.

Frequency spread spectrum contributes further to quiet performance by dispersing switching-noise energy.

The AP63356Q operates continuously in PWM mode at the nominal 450kHz switching frequency for all loads.



The AP63357Q changes to PFM mode at light loads, keeping efficiency as high as 86% at 5mA load and drawing quiescent current of 22μA under no load.

Both have low-dropout operation, which maintains their output-voltage regulation as the input reduces to a level near the output voltage.

Built-in protection includes output under-voltage, cycle-by-cycle peak current limit and thermal shutdown. They have a 40V for 400ms input voltage surge withstand capability.

Both are qualified to AEC-Q100 grade one, support PPAP documentation, and are manufactured in IATF 16949 certified facilities.

They come in 3 by 2mm V-DFN3020-13 (SWP) packs with wettable flanks to aid automated optical inspection.

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