VEHICLE electronics

The monthly magazine for automotive electronics engineers

Intel takes Mobileye public

Intel is to spin off its Israeli Mobileye subsidiary into a seperate public company in mid-2022.

Mobileye specialises in driver-assistance and autonomous driving. It expects to deliver over 40% more revenue in 2021 compared with 2020, along with a record 41 new programme wins with more than 30 automakers worldwide.

It recently shipped its 100 millionth EyeQ system-on-chip, unveiled its production robotaxi, and scaled its autonomous vehicle testing across multiple cities around the world covering the USA, Europe and Asia.

With the support of its board of directors, Intel says it plans to take Mobileye public in the USA in mid-2022 via an initial public offering (IPO) of newly issued Mobileye stock. The move will unlock the value of Mobileye for Intel shareholders by creating a separate publicly traded company.

Intel will remain the majority owner of Mobileye, and the two companies will continue as partners, collaborating on projects as they pursue the growth of computing in the automotive sector.

Mobileye's executive team will remain, with Amnon Shashua continuing as CEO. Recently acquired Moovit as well as Intel teams working on lidar and radar development and other Mobileye projects will be aligned as part of Mobileye.

Intel acquired Mobileye four years ago.

"Intel's acquisition of Mobileye has been a great success," said Intel CEO Pat Gelsinger. "Amnon and I determined that an IPO provides the best opportunity to build on Mobileye's track record for innovation and unlock value for shareholders."

Mobileye's recent wins range from core driver-assistance technology to full self-driving systems. The company has also secured deals for mobility-as-a-service (MaaS) starting in 2023, as well as consumer and business-to-business vehicle production designs for Mobileye's self-driving system starting in 2024.



Mobileye was acquired by Intel in 2017

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Green Hills and Lantronix create secure platform

Green Hills Software and Lantronix have formed a partnership to create safe and secure computing platforms for those building critical automotive electronic systems.

This combines Qualcomm Snapdragon automotive dev kits from Lantronix with Green Hills' safety-certified Integrity rtos, Integrity Multivisor secure virtualisation services, and Multi development tools and C/C++ compilers.

Ultimately, the platform can lower the complexity and mitigate the difficulties of integrating the hardware and software for critical automotive electronics systems to help OEMs and their suppliers reach production more quickly.

"Today's electronics manufacturers must overcome growing challenges to develop and deploy their next-generation systems targeting safety and security-critical automotive applications," said Jacques Issa, vice president at Lantronix.

The Lantronix hardware development kit uses the Snapdragon SA8155P processor, audio-video expansion headers and Android. When combined with Green Hills tools, the platform enables rapid evaluation and benchmarking, component unit testing, and peripheral testing. It also lets users create proof-of-concept trials and market-ready prototypes.

Immediate firmware and application development can be carried out by distributed software teams. Integrated deep-visibility and safety-certified software tools help developers find and fix software bugs.

It also provides the ability to consolidate and run functions safely with different safety or security requirements, for example run Linux and Android alongside functions certified to ISO 26262 Asil D.

ADI celebrates Linux anniversary



As the Linux open-source operating system marks its 30th anniversary, Analog Devices has expanded its Linux distribution by recognising more than 1000 of its peripherals supported by in kernel Linux device drivers.

It has also released Kuiper Linux, a free Linux-based operating system based on Raspbian and Debian that is optimised for ADI peripherals and supports Arm-based systems such as Raspberry Pi, Xilinx Zynq, Zynq Ultrascale+ MPSoC, and Intel Cyclone V SoC, Arria 10 SX SoC and Stratix 10 SoC.

The open-source device drivers streamline the software development process, providing access to tested, high-quality software to create innovations across industries, including automotive. The portfolio includes products from recently-acquired Maxim Integrated.

The new Linux distribution focuses on ensuring ready-to-use in kernel Linux device drivers and contains the essential components for running the built-in drivers.

"With these drivers, we can serve our customers in a more holistic manner by streamlining the software development process and making it more cost and resource efficient," said David Babicz, director of engineering at Analog Devices.

Mercedes receives UN-R157 approval

Mercedes-Benz is the first automotive company to meet the legal requirements of UN-R157 for an SAE level-three system.

KBA, Germany's federal motor transport authority, has granted the approval, thus paving the way for offering such a system internationally, provided national legislation allows it.

Germany opened the Road Traffic Act for level-three systems in 2017. This is why customers will be able to buy an S-Class with Drive Pilot in the first half of 2022, enabling them to drive in conditionally automated mode at speeds of up to 60km/h in heavy traffic or congested situations on suitable stretches of motorway in Germany.

The equipment takes the strain off the driver and allows him or her to perform ancillary tasks on the central display such as online shopping or processing emails in the in-car office.

"For many years, we have been working to realise our vision of automated driving," said Markus Schäfer, Mercedes-Benz chief technology officer. "With this lidar-based system, we have developed innovative technology for our vehicles that offers customers a unique, luxurious driving experience and gives them what matters most: time."

The technical approval regulation did not come into force until the beginning of 2021. Since then, it can be implemented in Europe. Germany was the first country to create a legal basis for the intended use of these systems.



Drive Pilot lets the driver do other things

Mercedes-Benz is initially offering Drive Pilot on 13,191km of motorway in Germany. Test drives are underway in the USA and China. As soon as there is a national legal framework for conditionally automated operation in additional markets, the technology will be rolled out step by step.

Codeplay and ESol enable open-standards programming

Embedded software company ESol is working with Codeplay Software to develop safe embedded applications for automotive and industrial applications running on multicore real-time systems.

Codeplay led the creation and definition of Sycl, Khronos Group's open standard C++ programming model for heterogeneous processor architectures in artificial intelligence (AI) and high-performance computing (HPC).

Codeplay will integrate its Acoran software with ESol's EMCos scalable rtos platform allowing adas application developers to port their software using modern C++ to ESol's framework.

The integration will start with a multicore CPU environment and then grow to support integrated accelerators for AI and computer vision (CV) functions. AI and CV are being adopted for automotive systems to provide enhanced safety and control, reducing accidents, saving lives and taking into account increasing autonomy of vehicles.

Acoran provides programmability, optimised processor-specific routines and an ecosystem of domain-specific libraries for AI. A foundation of Acoran is Sycl, an open standard programming model that enables heterogeneous programming based on standard ISO C++.

EMCos is an rtos for embedded applications with functional safety requirements. It combines a common Posix user interface with an underlying multi-kernel architecture to increase performance on modern multicore and many-core hardware by reusing available source code.

It was developed from scratch and designed to meet automotive and industrial critical embedded applications.

"Our customers have the highest demands for quality and safety," said Bob Ueyama, executive vice president of ESol. "They are also eager to apply AI and HPC to their real-time embedded systems to meet the growing demand for autonomy."

Wittenstein and RTO partner on safety-critical software

Wittenstein High Integrity Systems and Real-Time Innovations (RTI) are working together to help developers create embedded applications targeting the safety critical market.

Through this collaboration, developers can follow a path to safety certification from prototype to production.

Developers can use commercial development paths to safety certification with commercial off-the-shelf software from prototype to release using Free Rtos, Safe Rtos and RTI Connext.

Safe Rtos is Wittenstein's pre-emptive, safety critical rtos that delivers determinism and robustness for embedded systems. Connext is a software framework for autonomous systems, and Connext Cert provides the real-time data connectivity for safety-critical systems such as autonomous vehicles, connected healthcare and avionics.

Both companies offer pre-certified software at the ISO 26262 Asil-D level.

Safe Rtos is available pre-certified by TÜV SÜD to Asil D and IEC 61508 SIL 3.

Developers can prototype using Free Rtos and convert to Safe Rtos at the start of formal development.

Connext Micro is a lightweight connectivity framework that works with Free Rtos in early prototype environments of resource-constrained applications that require real-time performance.

Once the application is ready to move to the commercial stage, developers can migrate to Safe Rtos and Connext Cert, which provide the production-grade technology.

When integrated with Safe Rtos, Connext Cert will let developers build applications on the latest safety microcontrollers, providing a foundation to support safety-critical applications.

"Technology partnerships such as this between Wittenstein and RTI are vital for the industry," said Andrew Longhurst, managing director of Wittenstein. "There is a natural fit between Safe Rtos and RTI Connext Cert that will be of great benefit to automotive developers focusing on safety."



Funzin integrates KDPOF transceiver

Funzin has integrated KDPOF's KD1053 IC and KD9351 fibre optic transceiver in its FAIP 3.0 AIoT platform and Photon edge AI device for automotive.

"An automated driving car requires networks capable of controlling and processing a great deal of sensor data," said Deuk Hwa Kim, Funzin CEO. "Our automotive network features an Ethernet backbone environment based on plastic optical fibre (POF) to eliminate electronic wave interference."

The system provides the gigabit communication infrastructure needed for sending and receiving high-capacity data.

"We are happy to support the FAIP 3.0 and Photon with our new KD9351 FOT that, in combination with the continuing KD1053 IC, cuts the cost for 1Gbit/s by 30 per cent compared to shielded twisted pair of copper wires," said Carlos Pardo, CEO of KDPOF. "By constructing the transimpedance amplifier, photodiode, LED driver and LED as one single device, the integrated KD9351 provides efficient optical connectivity for safe backbone and adas sensor links in vehicles."



Deuk Hwa Kim

The optical cables are reliable and at least as flexible as copper cables in the same bandwidth range. They allow fast, dynamic and tight bending as well as immersion in dark liquids.

FAIP 3.0 and Photon contain a controller board, a POF QHD camera and POF cable. The carrier board supports the connection with various POF legacy devices.

It provides eight optical interfaces with the KD1053 and KD9351, delivering bandwidths of 1Gbit/s each.

The KD9351 reuses low-cost mems encapsulation and allows SMD reflow assembly with 8 by 7 mm LGA components. It is shielded against electromagnetic radiation.

Fibre connection is done with a simple plastic connector placed on top. The temperature range from -40 to +105°C conforms with harsh automotive environments.



LG IVI in the Renault Mégane E-Tech Electric

LG IVI makes debut in Renault Mégane

LG Electronics' latest in-vehicle infotainment (IVI) system will make its debut in 2022 in the Renault Mégane E-Tech Electric.

The software that powers the IVI system was developed by LG in partnership with Renault and is based on Google Android Automotive.

It is the first software developed by LG using scaled agile framework (Safe), a set of principles and processes to help large organisations adopt agile methods to develop and deliver high-quality products and services faster.

This software operates independently from the vehicle's hardware to provide convenience-enhancing features such as the ability to update the operating system over the air and remotely check vehicle charging status.

This is the first system based on Android 10 to receive certification from Google Automotive Services (GAS). The platform offers intelligent infotainment services and access to various Google apps including Google Assistant, Maps and Play via the centre information display.

"Digital cockpits have quickly transformed how drivers and passengers interact with their vehicles, allowing for more personalisation and enhanced comfort," said Thierry Cammal, vice president at Renault. "We believe that our continued collaborative work with LG has been critical to deliver an outstanding Android cockpit for our Mégane E-Tech Electric."

LG's vehicle component unit recently acquired automotive lighting and headlight systems provider, ZKW Group, and formed a joint venture with Magna to create the LG Magna e-powertrain, which launched in July.

Collaboration adds security to occupant monitoring

GlobalLogic, Jungo and OpenSynergy have developed an automotive virtual driver monitoring system (DMS) that delivers security, convergence and implementation ease.

It integrates a standalone DMS currently provided on a separate ECU with an existing automotive cockpit controller to provide input to the instrument cluster for drowsiness trigger and in-vehicle infotainment (IVI) for gesture control, while safely and securely isolating personal data from other functionalities.

The virtual DMS allows OEMs to define use cases and reduce hardware costs, while protecting sensitive data against malicious attacks.

Using a small camera and dedicated software, the DMS can precisely observe and evaluate the driver's behaviour. The system analyses the position of the driver's head and eyes, using the collected data to determine which actions to take.

It can recognise that the monitored person is not looking at the road perhaps because they are preoccupied with their smartphone or that they are beginning to fall asleep or lose consciousness. Once a hazardous situation is detected, the DMS can perform a number of actions to prevent a possible accident, including intense light or sound signals and even an emergency stop procedure including a call for medical assistance.

CoDriver, Jungo's driver and occupant monitoring AI software, helps OEMs comply with upcoming regulations regarding driver distraction, drowsiness and unattended children.

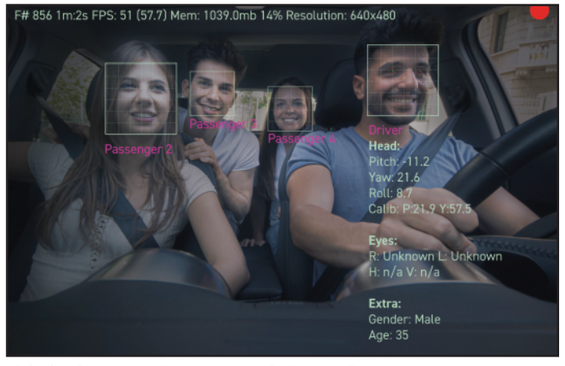
A virtualised DMS integrated on OpenSynergy's Coqos Hypervisor SDK automotive virtual platform can run in parallel with other systems on the same SoC. For example, it can run in parallel to an Android OS as it provides each function with its own virtual machine. Since the Android is connected to the internet, it forms a gateway for unwanted access from outside.

The DMS stores and protects personal data, making unauthorised access impossible.

This partitioning approach also acts as a firewall protecting against external attacks.

"Consolidation offers fantastic potentials to save costs and create new exciting features," said Jonathan Siegel, portfolio manager at OpenSynergy. "But there are legitimate concerns about data privacy. Coqos Hypervisor supports new appealing use cases by allowing features to share information and ensures that the sensitive data are protected, even in the case of a malicious breach."

GlobalLogic engineers integrated the system designed by Jungo with the capabilities of the hypervisor developed by OpenSynergy to help automotive manufacturers and software providers implement the technology in new car models.



GlobalLogic, Jungo and OpenSynergy develop virtual driver monitoring

Traffilog buys SafeRide

Telematics company Traffilog has acquired SafeRide Technologies, a specialist in artificial intelligence (AI) for the automotive industry.

The combined company will provide telematics and analytics services to car makers and fleets with hundreds of thousands of vehicles worldwide.

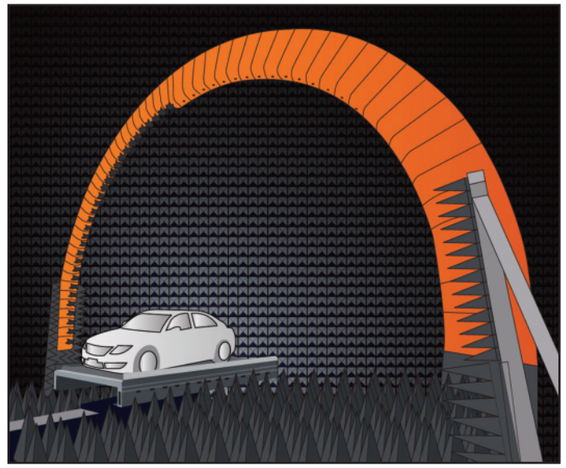
It will also continue to collaborate with automakers and tier-one suppliers to integrate AI-based software into vehicles.

The consolidated company will have global reach, with presence in San Francisco, Detroit, Germany, South Korea and Israel.

"Combining SafeRide's AI and deep learning technologies with Traffilog's data collection and management capabilities as well as its strong customer-base will enable us to take a huge step forward," said Erez Lorber, CEO of Traffilog, who will be CEO of the consolidated company.

Anritsu and MVG provide 5G OTA RF test for Toyota

Anritsu and Microwave Vision Group (MVG) have partnered to deliver the MT8000A radio communication test station and MVG over-the-air (OTA) system to Toyota as what is said to be the world's first 5G vehicle OTA RF tester.



Anritsu and MVG deliver 5G tester to Toyota

Realising autonomous driving requires simultaneous communications with the surrounding environment, including other vehicles, road infrastructure and networks.

In particular, introducing 5G supporting large-capacity, low-latency, massive connections is key technology to transferring the large data volumes generated by various sensors, such as vehicle cameras, as well as for 3D high-definition mapping data.

Consequently, car manufactures, and telematics unit suppliers are pushing forward with development of 5G communications products.

However, before release, the connected vehicle communications performance must be tested and verified in an OTA environment simulating the actual environment.

The all-in-one MT8000A is a 5G base-station simulator for 5G RF and protocol measurements as well as application tests. It supports high-order 4x4 mimo and carrier aggregation technologies for fast, large-capacity communications.

As well as focusing on smartphone testing, it covers 5G communications function tests and evaluations of antennas and high-frequency parts.

To characterise an antenna, it is necessary to measure its radiation patterns to determine how well, and in which direction, it radiates. To obtain reliable 3D radiation patterns quickly, antenna performance tests are moving towards OTA testing to obtain fast and reliable measurements at the system level.

For OTA measurements, the tests are performed through a radio communication tester and conducted using near-field measurement in an anechoic chamber to block external electromagnetic fields and to simulate realistic and complex RF scenarios.

Addressing the complexity of measuring highly connected vehicles, MVG offers OTA measurement designed for the complete verification of automotive wireless performance. Thanks to a high precision positioning controller and turntable system, continuous on-the-fly measurements can be performed. This allows for quick and accurate measurement of directivity, gain and efficiency.

"To deliver a full-vehicle OTA test that meets the needs of current and future vehicle testing, we needed to integrate a radio communication test system supporting 5G frequencies," said Per Iversen, MVG chief technology officer. "We believe that MVG's OTA test environment combined with the Anritsu MT8000A is the right combination to meet the test needs of tomorrow's connected vehicles."

Cissoid and Silicon Mobility develop EV power module

Silicon Mobility's Olea field programmable controller unit (FPCU) is being integrated with Cissoid's silicon carbide (SiC) IPM intelligent power module to accelerate the development of compact and efficient SiC inverters for electric vehicle motor drives.

The partnership aims to deliver a SiC inverter modular platform offering integrated hardware and optimised software, a power module and its gate driver with protections and fault management, a fast FPCU, and its application software optimised for e-motor control.

The resulting SiC inverter platform should be available by early Q2 2022.

Ambarella acquires Oculii to access radar AI

AI vision silicon firm Ambarella has acquired Oculii, a developer of adaptive AI software algorithms to give current production radar chips up to a hundred times higher resolution, longer range and accuracy.

These improvements eliminate the need for specialised high-resolution radar chips, which have higher power consumption and cost than conventional radar.

Oculii's software can be deployed on Ambarella's existing CVflow SoCs, operating with radar RF to increase safety and reliability.

The acquisition expands Ambarella's addressable market into radar perception and fusion with its existing edge AI CV perception SoCs for automotive and other IoT endpoint applications, including mobile robotics and security.

The fusion of Ambarella's camera technology and Oculii's radar software stack provides all-weather, low-cost and scalable perception, enabling higher levels of autonomy for automotive tier-ones and OEMs.

"The Oculii team brings great synergies with Ambarella's algorithm-first approach and our ongoing initiatives to intelligently fuse sensor data in edge AI systems," said Fermi Wang, CEO of Ambarella. "We expect Oculii's unique adaptive radar perception algorithms, combined with Ambarella's vision and AI processing, to unlock greater levels of perception accuracy than attainable with discrete camera and radar."

Oculii's resolution and sensitivity can unlock the potential of everything from adas and autonomous vehicles to robotics and security, by providing radar with a dynamic waveform that uses AI to learn from and adapt to the environment. The result is an operating range of up to 400m with a wide field of view.

"Joining Ambarella will enable Oculii to expand the development of our radar technology while leveraging our synergies as part of this leading vision and AI processor company," said Steven Hong, CEO of Oculii.

To date, Oculii is engaged with ten of the top fifteen tier-ones on software licensing, and has commercial development contracts with OEM and AV companies.

Can Bentley's night vision save Christmas?

After receiving an urgent message from the North Pole, Bentley has deployed a Bentayga equipped with its suite of driver assistance systems to track down a very special missing reindeer.

The customer was troubled by the absence of a vital member of his team, one tasked with plotting and navigating a global grand tour of exceptional scale (some 66 million kilometres in just one night) through the apparent power of a shiny red nose.

Fortunately, a feature of Bentley's adas is night vision, which will be crucial to locate the animal in time for Christmas.

The night vision consists of three main components: a festive isolating reindeer (FIR, also known as forward infra-red) imager, an electronic control unit and the driver instrument panel.

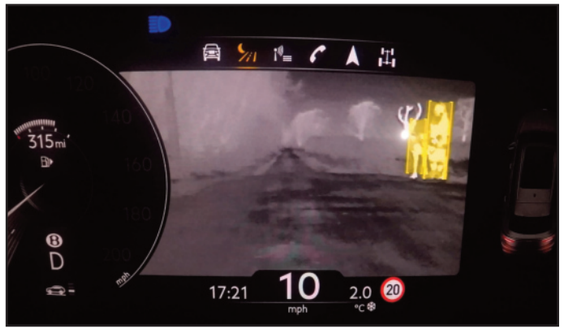
The FIR imager is a thermal imager that captures infra-red energy up to 140m in front of the car via fixed focus optics with a 24˚ degrees of horizontal field of view beyond the vehicle.

Mounted within the front grille of the Bentayga, the imager has its own wash outlet, to clear road grime, dust, ice and reindeer droppings.

Small animals of 1m in size can be detected from 7m in front of the vehicle, while larger animals of 2m and above can be detected up to 140m away.

The thermal resolution of the system is sufficient to detect the tread pattern in tyres and, more importantly, the radiant heat of the shiniest of red noses.

The race is now on to find the shiny-tipped reindeer, with people across the world called to action using the antlernet to save Christmas.



Bentley night vision detects Rudolph's nose

Adlink collaboration focuses on full C-V2X applications

Adlink has joined forces with Askey Computer, Taiwan's Institute for Information Industry (III) and Excellence Opto (EOI) to develop and deploy end-to-end C-V2X.

The collaboration integrates AI-enabled technologies and applications with 4G LTE and sub-6GHz 5G NR vehicle network connectivity, smart traffic lights, and signal controllers.

The C-V2X offering aims to improve road safety and traffic efficiency, establishing a foundation to accelerate innovation and commercialisation of intelligent transportation systems, autonomous driving and connected vehicles.

The 802.11p wifi standard established the foundation for V2X to enable drivers to avoid accidents and traffic jams. With a wider range than DSRC dedicated short-range communications and lower latency, 4G LTE and 5G based C-V2X can communicate real-time data further.

When used with onboard intelligence, it can accelerate more intelligent transportation and level-three and above autonomous driving.



Adlink and partners are enabling C-V2X applications in Taiwan

"We are seeing a strong momentum worldwide in developing and implementing C-V2X as the technology can substantially improve road safety and traffic efficiency, and revolutionise logistics," said Henry Hu, director at Adlink. "And, importantly, C-V2X can greatly accelerate technology innovation and commercialisation of autonomous driving. A quick and broad adoption of C-V2X requires extensive collaboration of industry participants, which is why Adlink is dedicated to building a comprehensive ecosystem."

The collaboration addresses the complex technology challenges from data collection to communication to processing in real time by leveraging Adlink's expertise in developing and deploying rugged AI-enabled in-vehicle computers, private 5G networks, 5G edge servers and intelligent edge infrastructure.

The C-V2X offering integrates Adlink's AI-enabled in-vehicle computer platform based on the AVA-3510 series, with Askey's onboard and roadside units, III's AI-enabled applications including image-based AI vehicle identification, tracking and warning technology, and EOI's smart traffic light and traffic signal controller.

There are already four C-V2X pilot projects across Taiwan that implement both direct sidelink and cellular network communications. These are testing use cases based on the enhanced 5G quality of service for reliable, low-latency and high bandwidth communications.

The first is an intelligent transportation application that uses V2X for controlling traffic in Taipei. The other three are for autonomous vehicles, signal phase and timing techniques at traffic signals, and an application that prioritises automated buses via a traffic light controller to optimise traffic flow for intersections.

GF and Ford tackle chip shortage

GlobalFoundries and Ford are jointly tackling the automotive chip shortage by advancing semiconductor and technology development within the USA.

The companies have signed a non-binding agreement that opens the door for GF to create a semiconductor supply for Ford's current vehicle range and joint research and development to address the growing demand for feature-rich chips to support the automotive industry.

These could include semiconductor products for adas, battery management and in-vehicle networking. GF and Ford also will explore expanded semiconductor manufacturing opportunities to support the automotive industry.

"It's critical that we create new ways of working with suppliers to give Ford and America greater independence in delivering the technologies and features our customers will most value in the future," said Jim Farley, Ford CEO. "This agreement is just the beginning, and a key part of our plan to vertically integrate key technologies and capabilities that will differentiate Ford far into the future."

Tom Caulfield, GF CEO, added: "GF is committed to building innovative alliances with the world's leading companies to enable the features in products that are pervasive throughout people's lives. Our agreement with Ford is a key step forward in strengthening our cooperation and partnership with automakers to spur innovation, bring new features to market faster, and ensure long-term, supply-demand balance."

Horiba Mira plans platooning trials early in 2022

Engineering consultancy Horiba Mira's collaboration with GMV NSL to develop passenger-car platooning for the European Space Agency (ESA) will move into live trials in early 2022, encompassing simulated and physical testing.

GMV NSL is the result of the merger in 2020 between UK aerospace company GMV Innovating and Nottingham Scientific. It specialises in satellite navigation and critical applications.

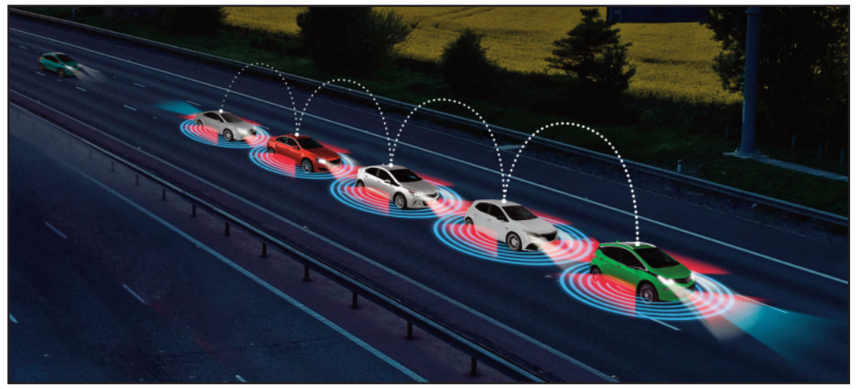
The project aims to advance platooning – the process of optimising the coordination of traffic streams – by embracing a number of technologies.

The first of these is cooperation between all the cars in the platoon to share information about their respective positions on the roadway. Cooperative positioning is enabled with range-finding sensors, such as radar, with data shared between cars via low latency wireless communications. For these data to be trusted to inform the management of the positions of the cars in the platoon, they are evaluated by an integrity algorithm.

A platoon automatically optimises the flow of vehicles along highways and prevents the characteristic phenomenon of waves of braking and acceleration events, known as perturbations, transmitting through streams of traffic when vehicles are manually driven at high levels of density, such as during rush hours.

The project to automate platoons of cars travelling on motorways should allow passengers to enjoy smoother driving conditions by optimising throttle and brake profiles, which in turn improves vehicle efficiency and reduces emissions.

The improved throughput on existing highway infrastructure also reduces the requirement for new road building.



Platooning should lead to smoother driving

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Microchip and Mersen in SiC reference design partnership

Microchip Technology and Mersen have collaborated on a 150kVA three-phase silicon carbide (SiC) power stack reference design for e-mobility and energy storage.

The development provides designers with a complete, compact, high-power SiC product without the need for individual device sourcing, testing and qualification.

It includes Microchip's SiC power modules and digital gate drivers and Mersen's busbar, fuses, capacitors and thermal management.

"Microchip customers will benefit from our collaboration with Mersen to provide SiC mosfets and digital gate drivers," said Leon Gross, vice president of Microchip. "When power inverter designers can source a proven solution, they can avoid sourcing individual parts and reduce risk through reliability, and that helps avoid downtime. Designers now have an all-in-one evaluation system."

The design provides 16kW/litre of power density and up to 130°C Tj, peak efficiency at 98%, and up to 20kHz switching frequency. Using Microchip's rugged SiC mosfets and AgileSwitch configurable digital gate drivers, the reference design lets engineers select from 700 and 1200V options at up to 750A.

Microchip also provides a choice in module construction including baseplate material, direct bonding copper ceramic material and die attach method.

"We worked closely with Microchip on the design and development of this design given the availability of highly robust SiC mosfets and compatible digital gate drivers from a single source," said Philippe Roussel, vice president at Mersen. "Thus, we can demonstrate our ability to optimise any inverter topologies from our customers, relying on our line of highly reliable busbars, capacitors, fuses and cooling systems."



Reference design for e-mobility

QA and Absint develop Misra code checker

QA Systems has become the exclusive distributor for QA-Misra, a static checker for coding rules developed jointly with Absint.

The earlier in the development cycle software errors are identified, the less expensive they are to fix. It is optimal if errors do not even occur or are detected immediately.

"We know the market and the people involved," said Andreas Sczepansky, managing director of QA Systems.

QA-Misra already checks for more than 900 potential software errors in source code. Through static analysis, dangerous structures as well as problems with security, maintenance and porting can be found at an early stage.

It analyses complex software packages quickly, regardless of the size of the codebase. This simplifies quality management and helps compliance with relevant safety standards.

"After many years of involvement in working groups of the Misra consortium, we have created a convenient tool for efficient checking of coding guidelines, which has been maximally aligned to the needs of customers, with the help of the experts from QA Systems," said Christian Ferdinand, Absint managing director.

QA-Misra can be fully integrated into QA Systems' unit and integration testing tool Cantata. It automatically checks C or C++ code for compliance with Misra and Autosar rules, as well as the security standards SEI Cert C/C++, Common Weakness Enumeration (CWE), ISO/IEC TS 17961, Hersteller Initiative Software (HIS Metrics) and others.

INFOTAINMENT

Ken Waurin, Dietmar Ruwisch and Yu Du discuss how A²B technology and digital microphones improve performance in emerging automotive applications



CARRIED AWAY WITH SOUND

Recent advances in digital microphones and connectivity are enabling swift adoption of game-changing applications for future vehicle infotainment systems.

Within automotive cabins, it is becoming increasingly clear that the universe of audio-, voice- and acoustics-related applications is rapidly expanding as car manufacturers attempt to differentiate their vehicles from the competition.

Additionally, as consumers become more tech savvy, their expectations related to the driving experience and level of personal interaction with the vehicle are expanding significantly.

Home theatre quality sound systems are commonplace across all vehicle price points and are now being augmented by sophisticated hands-free (HF) and in-car communications (ICC) systems. Additionally, active and road noise cancellation (ANC and RNC) systems, historically deployed in only the top-level premium vehicles, are now making their way into more mainstream, affordable segments.

The common thread binding these legacy and emerging applications is the dependency on high performance acoustic sensing technology such as microphones and accelerometers. And since nearly all emerging applications require multiple acoustic sensors such as microphones or mic arrays to achieve the best performance, a simple cost-effective interconnect technology is required.

Historically, the lack of a microphone-optimised interconnect has been a significant pain point for car manufacturers, as each microphone would need to be directly connected to the processing unit using expensive and heavy shielded analogue cable. These added costs – primarily in terms of actual wiring, but secondarily in terms of added weight and reduced fuel efficiency – have in many cases prevented the widespread adoption of these applications, or at least limited them to only the super-premium segments.

Recent advances in digital microphone and connectivity technologies are proving to be enablers to the swift adoption of game-changing applications in vehicle infotainment systems.

Implementations

Using a handheld mobile phone while operating a vehicle is banned in most countries, while Bluetooth-enabled hands-free devices have become standard in almost all vehicles. A wide array of hands-free technology is available, from simple standalone units containing a loudspeaker and microphone to advancements that are completely integrated in the vehicle infotainment system.

Until recently, most hands-free systems were very similar. They were comprised of only one (rarely two) microphone(s), and the associated microphone technology was the fifty-year-old electret condenser microphone (ECM). The voice quality was often unsatisfactory, especially in simple standalone units where the distance between the microphone and the mouth could be large.

A typical automotive ECM combines the ECM capsule with a small amplifier circuit in a single housing. The amplifier delivers an analogue signal with a voltage level that allows transport over wires several metres long.

Without amplification, the original ECM signal would be too low for such a wire length, as the signal-to-noise ratio (SNR) would degrade too far due to electromagnetic interferences on the wire. Even the amplified signal requires shielded wiring, which is typically a two-wire cable with a bias (8V) that supplies the microphone device.

Given such wiring requirements, the number of ECM devices used in mainstream vehicles is limited due to weight and cost constraints.

One of the few advantages of ECMs is their built-in acoustic directionality, which is usually trimmed to a super- or hypercardioid polar pattern; a mems mic can also be made unidirectional but typically requires more complex acoustics.

Typically, 10dB or more backwards attenuation can be achieved, where backwards means the direction towards the windshield, from which only noise (that is, no desired signals, such as the talker's voice) originates. Having a higher sensitivity in the incoming direction of the desired signal can increase the SNR.

However, directional ECM capsules introduce unwanted side effects such as the high-pass characteristic where sensitivity decreases at lower frequencies.

The 3dB cut-off frequency of such a high-pass response is typically 300 to 350Hz. In the early days of HF technology, this high-pass behaviour was an advantage because engine noise was mainly at lower frequencies, so the engine sound was already

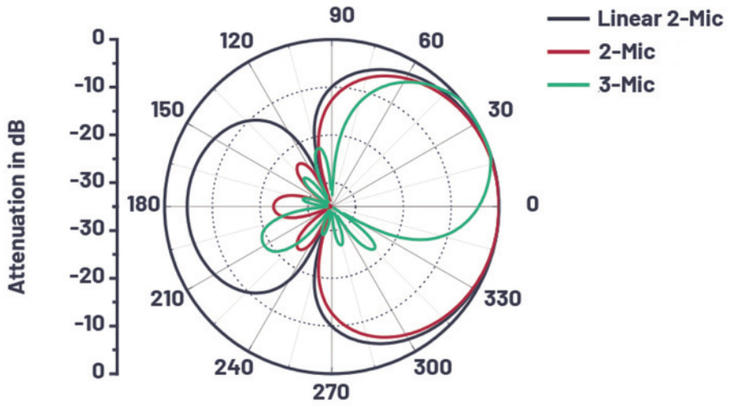


Fig. 1: Polar attenuation characteristic of different BF algorithms

attenuated through the microphone. However, since wideband, or HD, telephony, this high-pass behaviour starts to become a problem.

In a wideband call, the effective bandwidth is increased from 300 to 3400Hz, to 100 to 7000Hz. The built-in high-pass filter of the microphone makes it necessary to amplify signals between 100 and 300Hz in the postprocessing unit, which would not be required if the microphone were to deliver better audio bandwidth in the first place.

Another disadvantage of ECM is the part-to-part variation in terms of sensitivity and frequency response. If more than one microphone signal is deployed in a small-spaced array, then tight matching between microphones is essential for optimal array performance. In such a case, ECMs can hardly be used.

Furthermore, from the physical size perspective, traditional ECM capsules are not generally suitable for small form factor arrays.

Microphone arrays can provide similar, often superior, directionality performance compared with traditional ECMs. Spatial information regarding sound impact directions can be extracted from the microphone signals using two or more suitable microphones grouped in an array.

This class of algorithms is often referred to as beamforming (BF), covering linear and nonlinear algorithms that enable higher performance and greater flexibility than a simple linear beamforming process.

In addition to BF processing, a raw microphone signal almost always requires postprocessing because every HF microphone captures desired voice signals and disturbances in a car cabin. Wind, road and engine noise deteriorate the SNR, and signals played by loudspeakers – known as loudspeaker echoes – are also sources of unwanted signals.

To reduce such disturbances and improve voice quality, elaborate digital signal processing is required, such as acoustic echo cancelling and noise reduction (AEC and NR).

AEC removes the loudspeaker sound from the microphone, which otherwise would be transmitted as an echo of the voice of the person speaking at the other end of the line. NR reduces constant driving noise while increasing the SNR of the transmitted signal.

Although elaborate specifications define many performance details of an HF system, the subjective impression of the communication quality in a call from an operating vehicle can be unsatisfactory if the AEC and NR processing is substandard.

The bundle of AEC, NR and BF enables a wide array of new applications, all related with some digital audio signal processing.

Mems microphones

Microelectromechanical systems (mems) technology is swiftly becoming the new standard for microphones, as it offers many advantages over traditional ECMs. Mems enables a much smaller form factor than existing ECM capsules. Additionally, integrating a mems sensor with an analogue-to-digital converter (ADC) in a single IC results in a digital microphone that delivers signals ready for AEC, NR and BF processing.

Analogue-ported mems microphones without an integrated ADC are also available, but they share many of the same disadvantages as analogue ECMs. It is only with an all-digital interface technology that the interference and SNR problems inherent to analogue wires can be significantly alleviated.

Also, from a production perspective, mems are preferred because mems mics can be produced with a much tighter specification variance than ECM capsules, which is important for BF algorithms.

Lastly, with mems IC microphones, the manufacturing process is simplified because automated mounting techniques can be used, which reduces overall production costs.

Mems microphone elements are almost always manufactured to be omnidirectional, that is they have no intrinsic directionality of sound reception. As such, mems microphones are phase-true omnidirectional sound pressure sensors that deliver ideal signals for advanced BF algorithms, where attenuation directions and beam widths can be user-configurable via software.

As a rule, it is important all signal processing modules are grouped in an integrated algorithm suite. Processing latencies would needlessly increase and overall performance would be degraded if functional blocks were implemented in isolation from one another.

Standard linear BF and proprietary algorithms can help in understanding the performance potential of advanced BF algorithms.

The plots in Fig. 1 show three different BF algorithms regarding polar characteristics and frequency response in both in-beam and off-beam directions. A standard linear supercardioid algorithm based on a two-mic array serves as the benchmark (black curves). The benchmark curve shows the maximum attenuation in the typical zero-angle directions (that is, maximum off-beam attenuation) and a rear-lobe at 180°, where off-beam attenuation is lower.

The resultant rear-lobe is a trade-off with beam width in a linear algorithm. A cardioid beam (not shown) has its maximum attenuation exactly at 180°; however, its receptive area is broader than a hyper- or supercardioid configuration.

Beams with less significant rear-lobes and higher off-beam attenuation can be achieved with nonlinear algorithmic approaches, with the red curve showing a proprietary two-mic algorithm of this class; microphone spacing is 20mm.

With two omnidirectional microphones in an array, there is always a rotational symmetry of the beam shape.

The 3D beam shape can be imagined by rotating the 2D polar plot around this microphone axis. Asymmetric beam shapes without rotational symmetry or more narrow beams require at least three microphones in a triangle. For example, in a typical overhead console installation, a two-mic array can attenuate sound from the windshield. However, in such an orientation, a two-mic array cannot distinguish driver from passenger.

Rotating the array by 90° would make such driver-passenger distinction possible, but the noise from the windshield would not be distinguishable from sounds inside the cabin. Both windshield noise attenuation and driver-passenger differentiation are only possible using three or more omnidirectional microphones configured in an array.

An exemplary polar characteristic of a respective three-mic algorithm is given by the green curve in Fig. 1 where the microphones are arranged in an equal-sided triangle with 20mm spacing.

Polar plots are computed with band-limited white noise arriving at the microphone array from different angles. The audio bandwidth is limited to 100 to

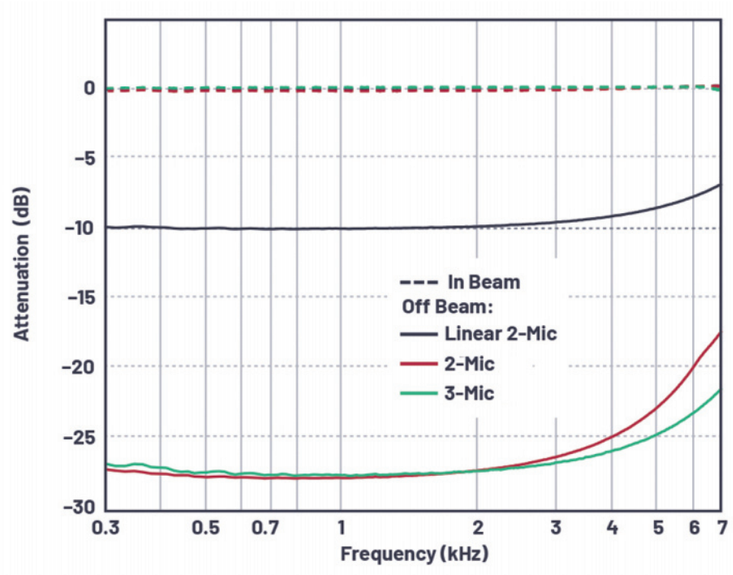


Fig. 2: In-beam (dashed lines) and off-beam (bold lines) frequency responses of different BF algorithms

7000Hz, which is the wideband (or HD-voice) bandwidth of the latest mobile phone networks.

Fig. 2 compares the frequency response curves of the algorithm types. In the in-beam direction, the frequency response of all algorithms is, as expected, flat within the desired audio bandwidth. Off-beam responses are computed for the off-beam half-space (90 to 270˚), confirming high off-beam attenuation over a wide range.

A²B technology

A²B (automotive audio bus) was developed to simplify connectivity in automotive microphone and sensor-intensive applications. From an implementation standpoint, A²B is a single-main, multiple subnode (up to ten), line topology.

A²B's daisy-chain line topology is an important advantage over existing ring topologies as it relates to overall system integrity and robustness. If one connection of the A²B daisy chain is compromised, the entire network does not collapse.

Only those nodes downstream from the faulty connection are impacted by the failure. And A²B's embedded diagnostics can isolate the source of the failure, signalling an interrupt to initiate corrective action.

A²B's main and subnode line topology is inherently efficient when compared with existing digital bus architectures. After a simple bus discovery process, zero additional processor intervention is required to manage normal bus operation.

Additionally, system latency is completely deterministic – a two-bus cycle delay, which is less than 50μs – irrespective of the audio node's position on the A²B bus. This is important for speech and audio applications such as ANC, RNC and ICC, where audio samples from multiple remote sensors must be processed in a time-aligned fashion.

For particular use cases, A²B technology offers a bus power capability that eliminates the need for local power supplies at the audio ECU.

The total 50Mbit/s bus bandwidth delivered by A²B supports up to 32 upstream and up to 32 downstream audio channels using standard audio sample rates and channel widths. This provides flexibility and connectivity to a wide range of audio IO devices.

Applications

Almost every new vehicle is equipped with at least one microphone module for HF communication. Premium and luxury cars may come with six or more microphone modules.

The growing microphone count presents one significant challenge to vehicle infotainment engineers: how to simplify the connecting harnesses and reduce their weight. This is not trivial for traditional analogue systems. At a minimum, an analogue microphone requires a pair of two shielded wires (ground and signal/power), pins and connector cavities for interconnection. The amount of wires is always twice the number of microphone modules in the system.

Meanwhile, the total weight of the harness could increase even more rapidly depending on the wire length needed for connecting each microphone module.

One simple way to mitigate this is to reduce the number of microphones in the system by sharing a microphone signal among multiple applications. For example, the same microphone signal could be used in HF communications and as an error signal in the ANC system. However, different applications may require different microphone characteristics.

An HF microphone signal often prefers a rising frequency response shape – that is, sensitivity decreases with decreasing frequency – to remove low frequency noise inside the cabin. This helps improve the speech intelligibility delivered by a voice microphone.

On the contrary, an ANC microphone requires sufficient sensitivity at low frequencies as the main purpose of the ANC algorithm is to reduce the low

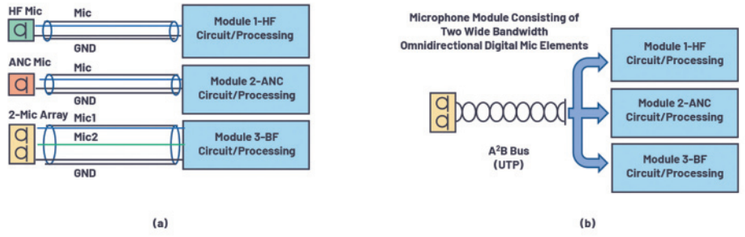


Fig. 3: (a) Analogue system design with analogue mic elements (shielded wires); (b) Digital system design with digital mic elements (A²B technology and UTP wires)

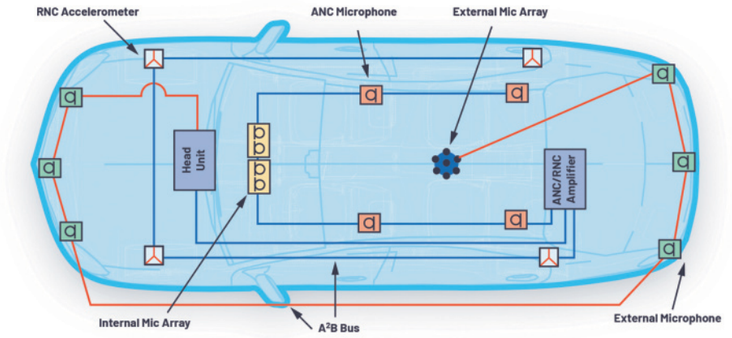


Fig.4: Common A²B microphones and sensors

frequency noise.

Thus, to share the same microphone in two applications in an analogue system, the signal coming from the microphone needs to be fed into different circuits for proper frequency filtering. In this case, one or multiple ground loops may form, which can cause significant noise issues.

As a digital bus with daisy-chaining capability, A²B technology and the digital mems microphone are well-suited for interconnecting and/or sharing multiple microphone signals demanded by audio, voice, noise cancelling and other acoustic applications that are rapidly expanding in vehicles.

Consider a case where a car application calls for an HF microphone module, an ANC microphone module and a simple array microphone module consisting of two microphone elements for BF, and all three are integrated around the overhead console area.

Figs. 3a and 3b show how such a design may be realised with the traditional analogue and the digital A²B systems, respectively.

Since the analogue system cannot easily accommodate microphone sharing, each application block (HF, ANC and BF) requires dedicated microphone(s) and separate harnesses for connecting to the corresponding functional circuit(s). This leads to four separate microphone elements and three sets of harnesses, a total of seven wires plus shielding.

In contrast, because sharing signals is easily supported by the digital A²B system, the number of microphone elements can be potentially reduced from four to two. In this example, a single microphone module consisting of two wide bandwidth omnidirectional microphone elements can provide two channels of acoustic signals that cover the needs of all application blocks.

Once these two channels reach the centre processing unit – such as the head unit or amplifier – through a simple UTP wire, they can be shared and digitally processed to support HF, ANC and BF applications.

Although the example in Fig. 3 may not represent a real situation, it demonstrates the benefits of the A²B technology over traditional analogue technology.

Fig. 4 shows some common automotive A²B microphones and sensors and how they can be used on a vehicle. These sensors include single A²B microphones and multi-element microphone arrays for ANC and voice communication, A²B accelerometers for RNC, externally mounted bumper A²B microphones, and rooftop A²B microphone arrays for emergency siren detection and acoustic environment monitoring.

Enabled by these A²B microphones and accelerometers, more applications requiring multiple sensor inputs are under development to enhance the user experience.

Summary

Vehicle architectures of the future will become increasingly more dependent on high performance acoustic sensing technology such as microphones and accelerometers. A completely digital approach including sensor, interconnect and processor provides significant performance and system cost benefits.







Ken Waurin (left) is strategic marketing manager and Dietmar Ruwisch (right) senior audio technologist, both at Analog Devices, and Yu Du (left) is senior principal acoustic engineer at Harman.

SAFETY & SECURITY



CALL THE FUZZ!

Ajey Gotkhindikar explores how fuzz testing can protect a vehicle from hackers

The ODB-II port is a possible point of entry for hackers into a vehicle's system but a fuzz-testing approach can be used to protect the vehicle.

The OBD port is connected to one or more communication buses for diagnostic purposes. An intruder can use this to send maliciously crafted UDS (unified diagnostic service) packets to identify and exploit the vulnerabilities present in vehicle ECUs.

A fuzz testing approach can identify the fuzzed data or hidden vulnerabilities that could potentially lead to anomalous behaviour of vehicle functionalities. The fuzz testing test suites are executed for UDS over the Can protocol based on ISO 14229.

Fuzz testing encourages secure development of automotive ECUs by detecting the possible fuzzed data prior to production, reducing the cost and time of bug fixation.

Introduction

The automobile industry is integrating many new features into connected vehicles where there is increasing interaction between ECUs connected over in-vehicle communication protocols. This enormous flow of data needs to be validated in the context of security to check if any potential vulnerabilities may lead to some compromise of core functionalities.

To find those real-time vulnerabilities over the Can UDS protocol, a black box fuzz testing approach has been developed.

The central idea of fuzz testing is the development of a fuzzer that generates and feeds invalid inputs

to the system under test (SUT). The behaviour of the SUT can be monitored, and anomalies reported.

Fuzz testing can be performed to find vulnerabilities on different interfaces and ECUs. The process involves getting the IDs and sessions from the SUT to perform fuzzing. Afterwards the creation of a positive test suit with valid Can messages can be done.

Further alteration of valid input request can be carried out with altered inputs provided to the SUT; its responses can be analysed for crash or halt.

By providing invalid input to the system, the behaviour of the ECU can be observed. The erroneous responses of ECU (vulnerabilities) can be found and reported. These requests and responses are stored in a file and analysed.

UDS

The UDS standard describes an application protocol interface used in road vehicles for diagnostics, debugging and configuration of ECUs. UDS defines how messages should be formatted but not how they should be implemented, although the standard suggests some good practices; that's why it is an interface.

Fig. 1 shows the structure and types of diagnostic messages. The UDS client is usually a tester unit meant to be connected to a vehicle diagnostic port. The UDS server is usually a device or name of ECU within the vehicle that is connected to the Can bus, accessible by the diagnostic port.

Each functionality of the standard is grouped within the concept of a service. A service is a type of request that has some parameters. Here are some examples of how functionalities are grouped within service identifiers:

- ECU reset – 0x11
- Diagnostic session control – 0x10
- Tester present – 0x3E
- Read data by identifier – 0x22.

These services can have sub-functions that are specific to them. For instance, the ECU reset service has a sub-function that describes the type of reset the client wants to perform. It can be a hard reset (power cycle) or a soft reset (restarting the firmware).

The sub-function is the first byte of the service payload, and its value is defined by UDS. The way the server triggers a reset is not defined by UDS and is left to the discretion of the server programmer.

When connecting to a server, the client has a session and a security level. By default, the server assigns the client to the default session in which only a few specific services are accessible, such as reading the DTCs. ISO 14229 defines four session types but defines the list of available services only for the default session. In other words, the ECU manufacturer decides what services are available for each session, excluding the default session. A client may switch to any session without restrictions with the diagnostic session control service. The ECU manufacturer

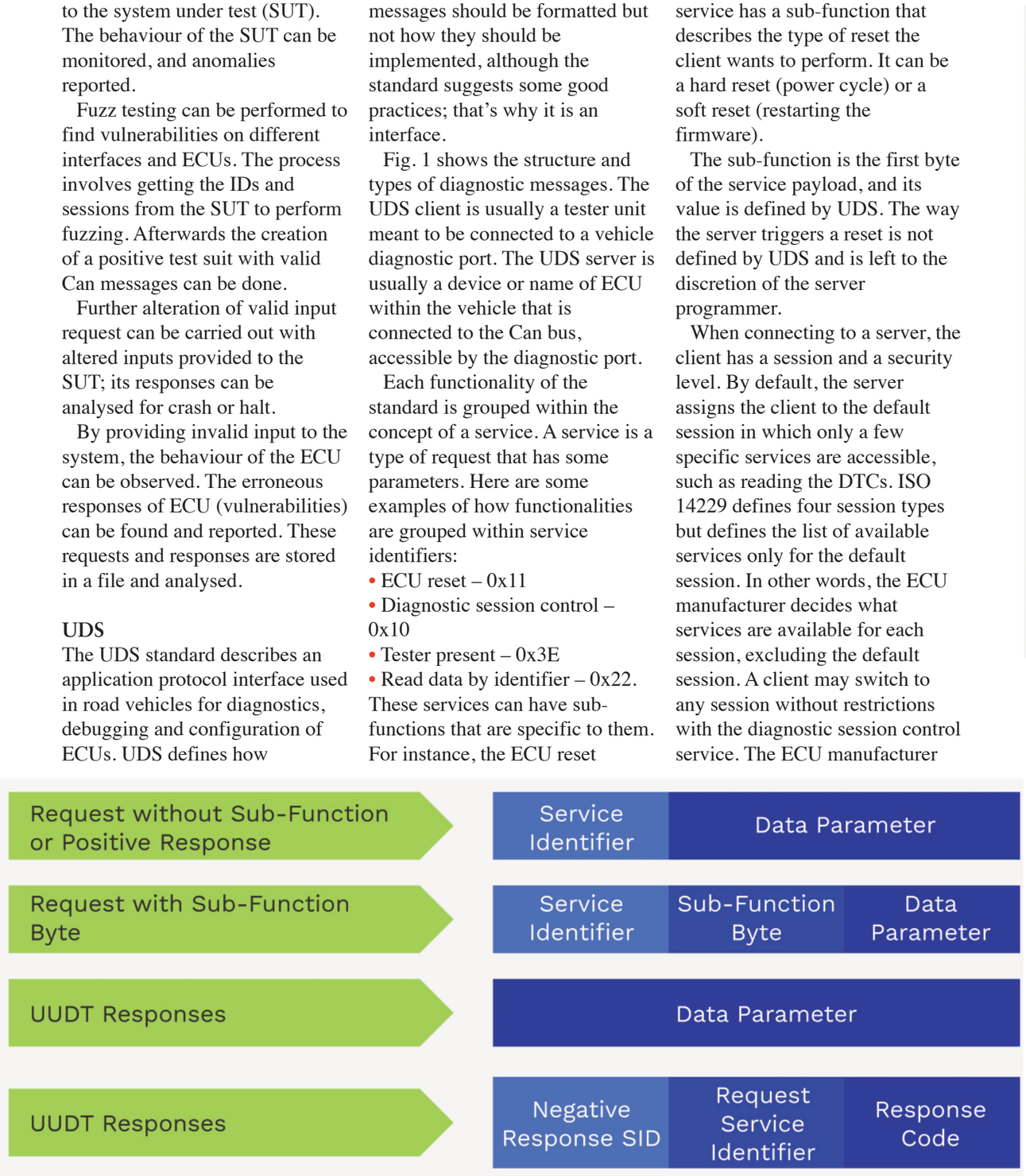


Fig. 1: Diagnostic messages – structures and types

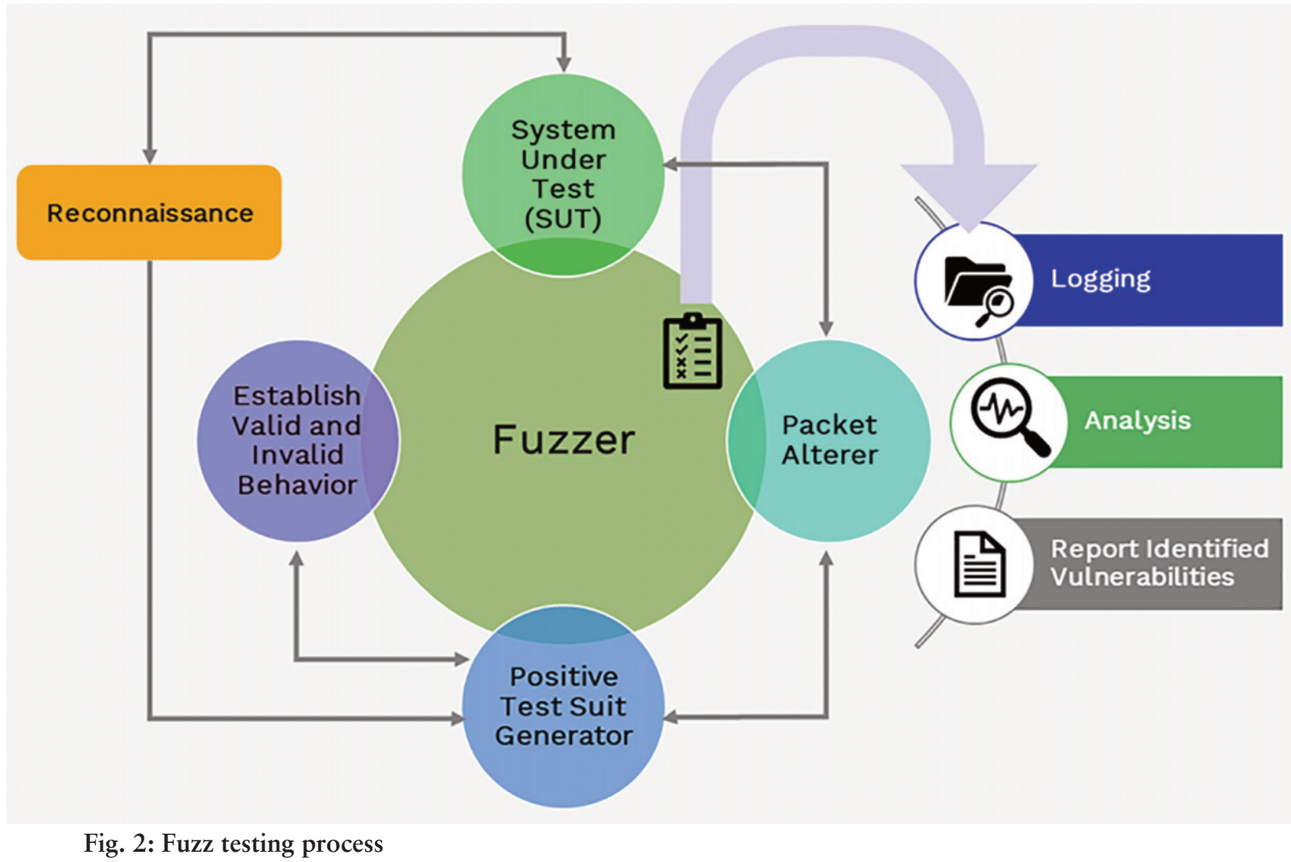


Fig. 2: Fuzz testing process

can define 32 additional sessions.

The security level is a status that the client gains by unlocking features within the server by providing a security key. UDS is designed to allow up to 64 security levels that are, in the end, Boolean flags set in the server. These security levels, and what they unlock, are not defined by UDS but will be by the ECU manufacturer.

A security level can unlock a whole service, a sub-function or access to a specific value. For instance, writing the vehicle identification number (VIN) may require a specific security level that is different from what is needed to write the maximum speed or override the vehicle IOs.

Unlocking security levels is not allowed in the default session. To gain some privileges, the client must first switch to a non-default session that enables the security access service. Only then may the client execute the handshake that will unlock the wanted feature.

Usually, when privileges are gained, they will expire after a short period of time defined by the ECU manufacturer. A keep-alive message will keep the security level unlocked and the session active; these keep-alive messages are sent with the tester present service.

The payload that must be sent to unlock a security level is not defined by UDS; UDS defines how to proceed with the key exchange. This process consists of two exchanges of request-response between the client and the server.

First, the client requests for a seed to unlock a specific security level identified by a number. This seed is usually a random value that the client must use to compute the key. It is meant to prevent someone from recording the Can bus message exchange and then gaining privileges by blindly sending what was recorded. In cryptography terms, the seed is a nonce used to avoid replay attacks.

Once the client gets the seed, it

must compute a key using an algorithm that is defined by the ECU manufacturer and known by the server.

The client then sends the key to the server, the server verifies it and, if it matches the server's value, the security level is unlocked, and a positive message is responded to the client.

The security algorithm can be any algorithm. The lack of algorithm definition in the UDS standard leaves some room for good security design but also for poor design – it's up to the manufacturer. Yes, some manufacturers implement security through obscurity, while some others will go for a more robust pre-shared key scheme.

Process flow

The aim of this experiment was to generalise the fuzzer algorithm such that it can be used for all ECUs using UDS over Can according to the UDS protocol.

By performing black box fuzz testing, a basic understanding of the system is gained. The reconnaissance phase provided system understanding. This was followed by generating a positive test suite based on the results of the reconnaissance phase. An alteration was implemented, and outputs were classified based on a set of criteria. Fig. 2 shows a fuzz testing process.

System under test

The process started by identifying the UDS over the Can port and OBD-II port and proceeded with a hardware setup.

For the hardware set up, the correct voltage was supplied and the SUT connected with a laptop using a USB 2 Can protocol converter. For setting criteria, monitoring, altering and analysing the packets, CAPL scripts were developed.

Reconnaissance

It is very important to find the diagnostic arbitration ID to carry out fuzz testing successfully. Identifying arbitration ID is an important step in communicating with the ECU via diagnostics over Can.

A CAPL script was developed that identified the arbitration ID. The Canoe-CAPL script played with the 8byte data field of the Can frame.

The arbitration ID field was sequentially alternated up to 11bit for the standard Can frame, keeping other data fields constant. Similarly, identification of which services have been implemented on the ECUs and the service IDs and the sub-function IDs were carried out.

Positive test

This step involves generating valid UDS requests. The UDS protocol standard and UDS over Can standard define application layer UDS requirements. This standard was studied and a positive test suite generated. The positive test suite is automatically generated by the fuzzer.

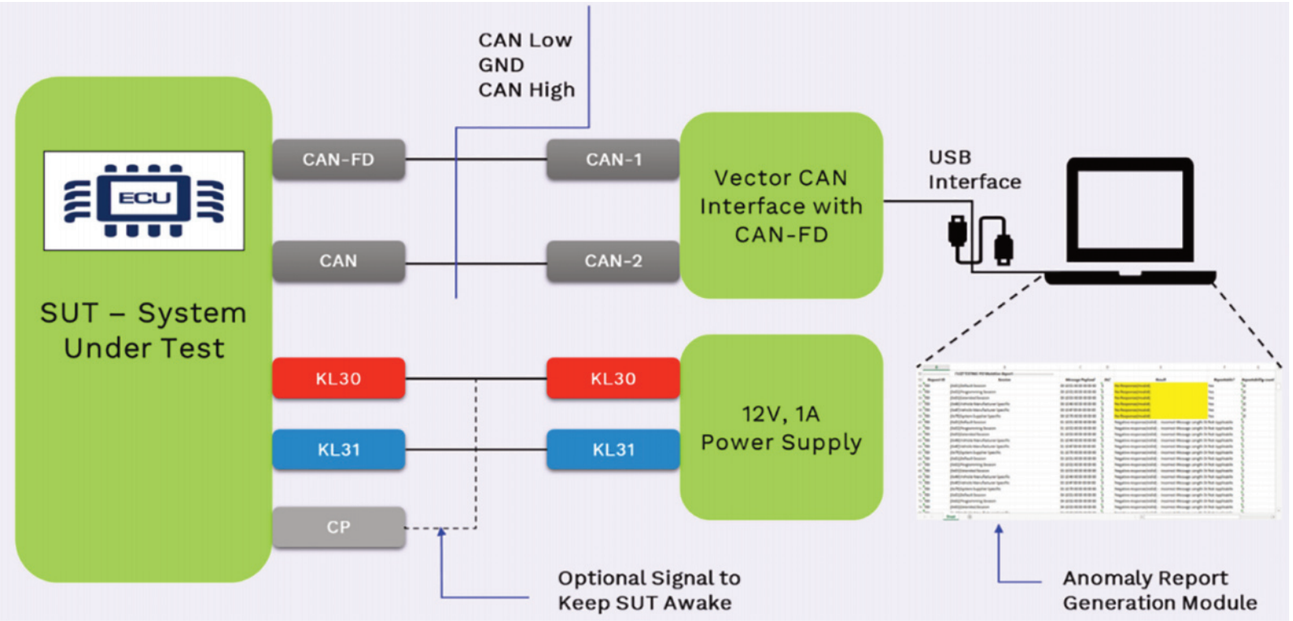


Fig. 3: Experimental set-up

	A	B	C	D	E	F	G
52	----------	FUZZ TESTING PCI Mutation Report----------					
53	Request ID	Session	Message Payload	DLC	Result	Repeatable?	Repeatability count
54	700	(0x01)Default Session	00 10 01 00 00 00 00 00	8	No Response(Invalid)	Yes	10
55	700	(0x02)Programming Session	00 10 02 00 00 00 00 00	8	No Response(Invalid)	Yes	10
56	700	(0x03)Extended Session	00 10 03 00 00 00 00 00	8	No Response(Invalid)	Yes	10
57	700	(0x40)Vehicle Manufacturer Specific	00 10 40 00 00 00 00 00	8	No Response(Invalid)	Yes	10
58	700	(0x4f)Vehicle Manufacturer Specific	00 10 4f 00 00 00 00 00	8	No Response(Invalid)	Yes	10
59	700	(0x70)System Supplier Specific	00 10 70 00 00 00 00 00	8	No Response(Invalid)	Yes	10
60	700	(0x01)Default Session	01 10 01 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
61	700	(0x02)Programming Session	01 10 02 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
62	700	(0x03)Extended Session	01 10 03 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
63	700	(0x40)Vehicle Manufacturer Specific	01 10 40 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
64	700	(0x4f)Vehicle Manufacturer Specific	01 10 4f 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
65	700	(0x70)System Supplier Specific	01 10 70 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
66	700	(0x01)Default Session	03 10 01 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
67	700	(0x02)Programming Session	03 10 02 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
68	700	(0x03)Extended Session	03 10 03 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
69	700	(0x40)Vehicle Manufacturer Specific	03 10 40 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
70	700	(0x4f)Vehicle Manufacturer Specific	03 10 4f 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
71	700	(0x70)System Supplier Specific	03 10 70 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
72	700	(0x01)Default Session	04 10 01 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
73	700	(0x02)Programming Session	04 10 02 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0
74	700	(0x03)Extended Session	04 10 03 00 00 00 00 00	8	Negative response(Valid) - incorrect Message Length Or	Not Applicable	0

Sheet

Fig. 4: Identified anomalies through fuzz testing

Systematic alteration

Mutation-based fuzz testing is an effective approach to improve the security and reliability of protocol implementations. The alteration-based fuzzer works on valid data and applies random changes to them.

That technique can reach deep into the message processing at the target.

Alteration of the valid input request was carried out. Altered inputs were provided to the SUT, and the responses analysed for crash or halt.

By providing invalid input to the system, the behaviour of the ECU was observed. The erroneous responses of ECU (vulnerabilities) were found and reported. These requests and responses were stored in a file and analysed. During analysis, a generated list of vulnerable messages was highlighted.

Alteration of a message length byte, sub-function byte with and without SPR-bit set, and data length code (DLC) were performed. Alteration for services without sub-function were also performed.

This process was done for services in both default and non-default sessions. This is because some services are implemented in default sessions, while some are implemented in non-default sessions.

Experimental set-up

The setup consists of the system under test. Fig. 3 shows an experimental setup for fuzz testing. Fuzz testing on several third-party ECUs has been performed. The SUT is connected to the Can interface. This is connected to a PC, which acts as a tester. The fuzzer scripts were run on Canoe-CAPL on the PC.

Conclusion

At the end of the fuzz testing process, a list of vulnerabilities was generated. These are responses that are neither negative nor positive according to ISO 14229-1.

This is achieved by developing data analysis-based algorithms for the report module.

The algorithm applies data analysis techniques on the positive test suite and ECU response for identifying anomalies that are then reported in an Excel sheet.

All the valid responses are also logged, and the anomalies are highlighted.

Fig.4 shows the anomalies highlighted in yellow. The report consists of arbitration ID, sessions, mutated payload and DLC, and the result.

Ajey Gotkhindikar is automotive cyber-security expert at KPit Technologies



SOFTWARE

SINGING IN TUNE



European consortium seeks to standardise software-defined cars

IT in cars is like an orchestra being joined by more and more musicians. Experts from industry and the scientific community now want to work together to create standard rules and processes so the various electronic players across the vehicle do not get out of sync.

After all, ensuring concerted interaction between all these systems is essential if new functions in and around the vehicle are to be developed more quickly in the future and reach drivers safely, throughout the vehicle's life.

This is what 13 companies and research institutions have been working on since August 2021 in the publicly funded Software-Defined Car project, or SofDCar for short.

"With a new approach to software and data, we're laying the foundations for much greater flexibility in dealing with new functions and data relating to modern vehicles," said Andreas Westendorf, project head at consortium leader Bosch.

The three-year project is being funded with a €43m grant from the German Federal Ministry for Economic Affairs & Energy.

Project partners include BooleWorks, Etas, Mercedes-Benz, P3 Digital Services, T-Systems, Vector Informatik, ZF Friedrichshafen and, as an associated partner, the Baden-Württemberg state agency E-Mobil BW. Scientific institutions also participating are the University of Stuttgart, Research Institute of Automotive Engineering & Vehicle Engines Stuttgart (FKSF), FZI Research Center for Information Technology, and Karlsruhe Institute of Technology (KIT).

Data complexity

Some of today's vehicles already have more than 100 control units, and this complexity of electrical and electronic systems and their architecture is only going to increase in the future. However, it is imperative to keep the complexity manageable, as this is the only way to ensure a vehicle's functions can be updated at any time in its service life – which may be as long as 20 years – and thus remain safe.

More than ever, what's needed is a set of rules governing the smooth interaction of the various in-car electronic components and systems.

The aim of the SofDCar project is to establish rules and processes for controlling all software updates and upgrades in the future, as well as a consistent functional and IT-security methodology to which they should adhere. This will prevent individual programmes from interfering with each other, and ensure they function properly within the system, without error.

"The SofDCar project has taken on the task of mapping the IT jungle in the car," Westendorf said. "Our objective is to bring fundamental order to the processes for creating and maintaining software for the vehicle domain via modern, cross-company development tool chains and devops methods. This will enable more complex functions and safety methods, which are also required for features such as automated driving."

Digital twin

Part of the project involves developing an extended digital twin – a virtual image of the vehicle's development and runtime data. In the future, this twin will encompass the data distributed across the vehicle and in the cloud, from the time a vehicle is manufactured until it is scrapped.

This goes beyond what was previously meant by the term digital twin: for the first time it covers the entire life cycle of a modern vehicle, and includes the cloud domain, apps, backend systems and development systems.

The project's plan is for this to ensure a single, unbroken information flow of vehicle data and software versions runs through all databases and servers. This will make it easier and above all quicker to implement software updates and new digital functions and services at any time.

"The digital twin is the car's IT-optimised partner, turning it into a modern electronic device in the cloud as well," Westendorf said.





LITTLE SECRET

Simone Bruckner investigates the dark side of EV batteries

Electric vehicles (EVs) have an unsustainable little secret; their batteries are the weak link in the sustainability chain.

EVs have been heralded as the answer to transportation's sustainability issues, providing scalability for the notoriously difficult-to-decarbonise sector. However, there's one key component that needs some work if EVs are to become a completely sustainable method of transport – the battery.

The electrification of the automotive market is a necessary step to reduce greenhouse gas emissions and ward off climate change's consequences. Every automaker is in support of the rollout, with more affordable models being released by the day to encourage consumers to make the electric shift. At the same time, governments are enforcing change through legislation that bans the sale of new fossil fuelled vehicles from as early as 2025.

The urgency of the climate crisis and looming legislation changes has resulted in the exponential growth of the EV market. A recent McKinsey report estimates that by 2035, the three largest automotive markets – the European Union, USA and China – will be fully electric. However, while driving an EV is zero emission, an unsustainable secret hides in production.

Traditional diesel and petrol-powered vehicles benefit from lead-acid batteries, which are widely recyclable. However, the same can't be said for EVs, which use lithium-ion batteries instead. Typically made from raw materials including cobalt, nickel and manganese, lithium-ion batteries are extremely expensive to produce and require high levels of mining activity.

Mining raw materials can lead to huge environmental destruction, releasing elements into the atmosphere that can contaminate soils and disrupt entire ecosystems. What's more, lithium-ion batteries are significantly more challenging to recycle, contributing to further environmental damage if improperly disposed of at the end of their life.

Aside from environmental devastation, lithium-ion batteries are also in short supply. Battery production capacity across the globe is expected to increase twenty-fold, but this won't be enough to meet the expected future demand.

Although several industry players are developing recycling methods and reducing the reliance on raw materials, any significant progress is far off. For now, to ensure demand is met and improve the output for using these materials, it's important for automakers to consider how they can make existing batteries last longer.

Extending lifespan

Automotive design engineers should consider the benefits that regenerative braking can bring in extending lithium-ion battery lifespan. A study by the Institute for Electrical Energy Storage Technology concluded that a higher level of regenerative braking usually reduces battery ageing by reducing lithium plating.

Lithium plating refers to the accumulation of metallic lithium on the battery's anodes, which can cause irreversible damage over time and significantly reduce battery lifespan. Lithium plating is exacerbated by long charging periods, but regenerative braking can help alleviate this issue.

Regenerative braking occurs when an EV recovers energy while decelerating by using its electric motor as an electric generator and converting kinetic energy into electrical energy. This electrical energy is then stored in the vehicle's battery, increasing range and efficiency between charges. Incrementally recharging the battery each time the vehicle brakes reduces the length of the charging period, therefore reducing the accumulation of metallic lithium and improving battery operations and life cycle.

Resistors play a crucial role in regenerative braking, by removing excess energy from the system in the event that the battery is already fully charged. This prevents overcharging or catastrophic damage to the system.

EVs are central to a more sustainable transportation system but they are not an answer to all environmental issues. Recognising the problems that they bring and considering both long- and short-term solutions is necessary to create truly sustainable transportation. While lithium-ion battery recycling could be a viable option in the future, extending battery life through techniques such as regenerative braking is essential to reduce reliance on finite raw materials from today.



Simone Bruckner is managing director of Cressall Resistors



EVs are not yet the answer to transportation sustainability

Touchscreen controller for different display ratios

A touchscreen controller from Microchip helps automotive designers satisfy various aspect ratios for touch displays in cars.

Part of the company's MaxTouch family, the MXT1296M1T can reconfigure its driving and receiving touch channels to match the exact screen format, from 1:1 to 5:1 aspect ratio, including the popular 8:3 automotive aspect ratio.



This lets the user efficiently use the number of touch channels available, without the need to select a larger, more expensive touch controller. Furthermore, they can save development and validation time and resources by reusing a common PCB design to support different touch sensor aspect ratios.

It enables the sensor channel reconfiguration by parameters. These settings do not require firmware modification, leading to lower design risk and faster time to market.

Two communication interfaces operate simultaneously, which allows a bridgeless connection to the back channel of the LVDS video link for touch information and a connection to a local microcontroller.

The bridgeless topology reduces touch latency to improve the user experience. It also guarantees compatibility with the MaxTouch software driver, available for all major automotive operating systems, including Linux, Android and QNX.

When connected to an appropriate local MCU, the second interface provides a redundancy link to the head unit through a Can bus or 10baseT1S Automotive Ethernet link for increased functional safety at the system level.

There are local access and control of the touchscreen controller's features, such as a capacitive keys report, live touch sensor diagnostics and raw data for external and custom post-processing.

Over-the-air and secure firmware update capability is available via the firm's TrustAnchor 100 companion chip.

The MXT1296M1T embeds various functional safety features to check constantly the integrity of the touch controller operation, as well as that of the connected touch sensors.

The failure modes effects and diagnostic analysis (FMEDA) and functional safety manual make it easier to design, build and certify a system for Asil-B applications to ISO 26262.

The device allows for high resolution transmit waveform control to lower RF emissions and avoid interference with the car radio or RFID systems.

A dedicated on-chip 64-level digital-to-analogue converter accurately shapes the waveform of the transmitting lines. This allows designers to control the frequency response precisely and optimise the harmonic emissions to meet OEM defined limits.



Photocoupler connects EVs

A high-voltage transistor output automotive photocoupler from Toshiba is for applications such as isolated signal communication in hybrid and battery electric vehicles.

The TLX9188 can be operated with a collector-emitter voltage of 200V minimum, the highest ever produced by Toshiba in an automotive photocoupler and 2.5 times higher than the current TLX9185A device.

Current transfer ratio is up to 600% and input-to-output isolation voltage 3750V RMS minimum.

It is housed in a four-pin SO6 package measuring 3.7 by 7.0 by 2.1mm, suitable for modern, densely packaged designs. Operating temperature is -40 to +125°C and it is qualified to AEC-Q101.

The ability to operate at high voltages makes it suitable for use in battery management systems in electric vehicles where it can monitor voltages, monitor for mechanical relays sticking and detect ground faults.

Current sensor uses Hall technology

An automotive current sensor from Infineon uses Hall technology for precise and stable current measurements.

The coreless Xensiv TLE4972 is for xEV applications such as traction inverters used in hybrid and battery-driven vehicles, as well as for battery main switches.

Due to proprietary temperature and stress compensation, it provides sensing without the negative effects caused by magnetic cores. Due to its differential sensing structure, neither core nor shield are required to protect the sensor against stray fields.

The integrated eeprom lets users customise the sensor for applications and it supports measurement ranges up to 2kA.

To protect the system, the sensor has two separate output pins for overcurrent detection with a typical response time of less than 1μs. Users can programme the sensitivity as well as the overcurrent limits and adapt the sensor to requirements.

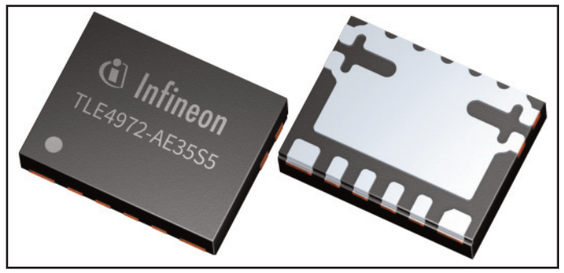
In addition, the drift of sensitivity plus offset over temperature is below 1.6 per cent.

The sensor causes low-power losses due to the magnetic sensing principle. Therefore, it can be used as a versatile and redundant option in 400 or 800V battery main switches.

The PG-VSon-6 package enables a compact design, making the device suitable for traction inverters.

Moreover, a second variant in a PG-TDSO-16 is offered. Both devices have been developed according to ISO 26262 as safety elements out of context for requirements up to Asil B.

Samples are available and mass production is planned to start soon.



Modular software boosts radome tester

The QAR50 from Rohde & Schwarz is for measuring radomes and bumpers in production.



The tester's design ensures short measurement times and accurate, reproducible results. Modular software allows it to be adapted to requirements.

Automotive radar sensor are often installed behind bumpers or emblems. Radome quality depends on the transmission loss, reflectivity and homogeneity of the components under test.

The instrument use microwave imaging. The interface can simplify measurements in the automotive radar frequency band. Measurement times are below five seconds.

The imaging method provides information on whether the components under test are properly positioned. The tester also displays the spatial distribution of reflectivity.

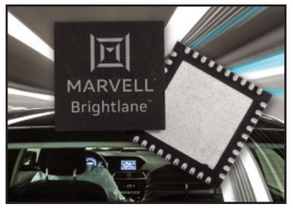
The clearance height of around 100cm between the antenna clusters reduces the mechanical effort required to position the components.

Phys help transition to software-defined vehicles

The 802.1AE Macsec integrated dual 1000BT1 and 100BT1 phys from Marvell can help OEMs transition towards software-defined vehicles, where secure communication of data is critical.

These Ethernet phys can enable energy efficient, secure in-vehicle networks and help achieve functional safety compliance at the system level.

Macsec technology secures data exchange on a hop-by-hop basis and prevents layer-two security threats such as intrusion, human-in-the-middle and replay attacks. Automotive networks rely heavily on partial networking in which some segments are hibernated and woken up on demand.



The phys support the Open Alliance TC10 for sleep mode and wake-up, tailored for automotive use cases. TC10 control signals are sent over the data line and reduce the need for special cables for remote control of the phy states.

The 1000BT1 88Q-2233M and 100BT1 88Q-120xM are additions to the Brightlane phy automotive portfolio.

They operate over unshielded twisted pair (UTP) cables, and support single 3.3V supply mode.

Marvell has also introduced a multi-gig Ethernet camera bridge, the 88QB5224, for video distribution in connected vehicles. This is also part of the Brightlane portfolio.

The bridge provides standardisation for in-vehicle video distribution in areas including IEEE 802.3ch compliant 10-GbaseT1 phy and IEEE 802.1AE Macsec for security, time synchronisation, energy efficient Ethernet for power savings, power over data line, and time sensitive networking.

The Ethernet-based camera bridge enables development of interoperable software that delivers services through a multi-layer communication stack.

LDO suits noise-sensitive use

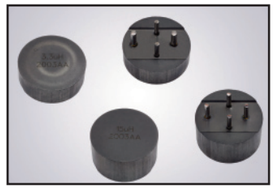
A low dropout (LDO) voltage regulator from Diodes is optimised for demanding noise-sensitive power-related automotive applications.

This AP7347DQ high output accuracy LDO is AEC-Q100 grade-one qualified, manufactured in IATF 16949 certified facilities, and supports automotive production part approval processes.

These make it suited to in-vehicle functions such as point-of-load applications in adas, automotive wireless communication systems, RF subsystems and infotainment power sources.

A 75dB power supply rejection ratio is combined with an output noise of 60μV RMS. It is available in 12 fixed output voltage variants with a ±1% voltage-output accuracy, which is maintained across its -40 to +125˚C operational temperature range. It has 1.7 to 5.5V input and 60μA quiescent current.





Through-hole inductors

Two automotive-grade high current and temperature through-hole inductors from Vishay come in the 1500 case size.

The Vishay Dale IHTH-1500MZ-5A at 0.47 to 4.7μH delivers a saturation current of 156A and typical DCR down to 0.19mΩ, while the IHTH-1500TZ-5A at 6.8 to 100μH has a saturation current of 106A and typical DCR down to 1.1mΩ.

Both can operate continuously at temperatures up to +155˚C.

Based on IHLP technology, the shielded, composite construction of the devices enables a size of 38.1 by 38.1 by 19.81mm.

This lets them replace larger and more expensive devices in high current filters for 12 and 48V hybrid electric and mild hybrid electric vehicle output converters; off-road diesel injection drivers; catalytic pulse width modulation heaters; and electrical motors.

They handle high transient current spikes without hard saturation and offer temperature conductivity via their housing.

Module combines GNSS and inertial measurement

To support the positioning market with GNSS chipset and modules, ST Microelectronics has combined the Teseo III GNSS IC with a six-axis mems inertial measurement unit and dead reckoning software to create an automotive-qualified navigation module.

The Teseo-VIC3DA module uses the firm's in-house manufacturing and software-development competencies to enable in-car navigation, fleet-management and insurance-monitoring applications.

The GNSS IC at the heart of the system is proven in high-end systems and already regarded for its accuracy and efficiency. Positioning capabilities come from simultaneously receiving signals from GPS, Galileo, Glonass, Beidou and QZSS constellations.

The six-axis automotive-grade mems IC adds high-resolution motion tracking to vehicle navigation and telematics applications.

The combination ensures accurate positioning performance in critical environments such as tunnels, beneath structures such as bridges or multi-level highways, in covered areas such as underground parking lots, and in urban canyons between tall buildings.

The module operates from 3.3V, helping simplify system integration, and has a standby mode that draws 17μA to reduce demand on the vehicle's electrical supply.

Containing an integrated TCXO, the module achieves accuracy of 1.5m CEP for typical automotive uses. In addition, a dedicated real-time clock oscillator helps ensure fast time to first fix.

Coming with firmware pre-loaded onto built-in flash memory, the module can be updated with firmware as necessary using the free Teseo-Suite software. The module can provide up to 30Hz dead-reckoning fix-rate and has low latency to reduce uart-channel jitter. It can autonomously work with and without odometer information.

Tested and certified to the EU's Radio Equipment Directive, applicable Etsi standards and EN safety standards, the module helps achieve mandatory product-level approvals. A standalone, USB-powered evaluation platform, EVB-VIC3DA, is available to jump-start development.

The module is in production and supplied in a 16.0 by 12.2 by 2.42mm 24-pin LCC package.

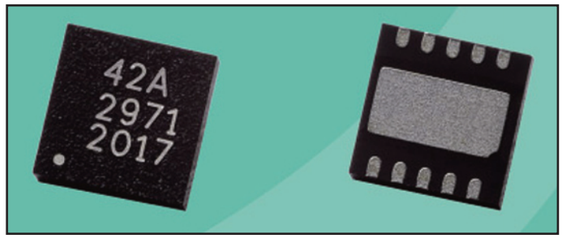


Pump driver handles high temperatures

A dedicated automotive pump driver from Melexis is said to meet requirements for high ambient temperatures and long operating lifetime.

The latest version is a 2.2A automotive-qualified pump and fan driver IC optimised to deal with high ambient temperatures and prolonged operational lifespans.

The MLX90412GLW single-coil IC with integrated driver stage is for applications with high ambient temperature such as automotive water pumps. It drives pumps up to 15W in internal combustion engines.



This typically implies a maximum ambient operating temperature up to +135˚C. While water pumps up to 20W can be driven within the maximum ambient temperature of +85˚C of EVs.

The device is qualified to meet an operating lifetime up to 15,000 hours in EV applications such as battery cooling.

The dedicated automotive one-coil motor driver includes protections.

Hall-sensor based one-coil water pumps are known for their robust start-up performance.

It can be configured in-BLDC commutation options from sinewave mode, offering low noise performance for EVs over a high torque mode, up to a low EMI mode for on-off applications requiring few external EMI filter components.

Merged component ups power density in EVs

An integrated magnetic component from Premo can increase power density for power converters in electric vehicles.

The 11kW 3DPower is a full-bridge LLC 150μH transformer plus a 25μH resonant choke merged in one unit. This provides up to 40 to 50% reduction in volume compared with discrete industrial products for the same power management.

Most power converters with resonant topologies in the market have a transformer, resonant choke and output choke. Each component has its own design, core, winding and thermal dissipation method.

This integrates two magnetics components sharing the same core and has two orthogonal magnetic fields at all points within the core. This enables power converter design with one inductive component and one mechanical drawing interface to fit and connect.

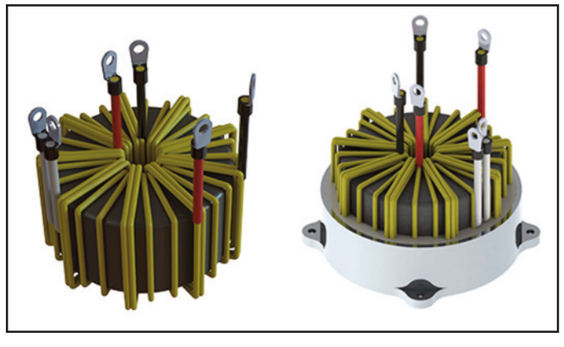
Once electromagnetic performance is reached, internal and external thermal links are the most important problem to solve in the design of these components. Designing power densities and power sizes over 7kW turns in a heat increase.

The component uses CoolMag, a fully silicon compound compatible with the magnetics and focused on power magnetic electronics to dissipate the heat from the top of the magnetic to the liquid cooling plate of the bottom. It provides thermal conductivity bigger than 1.7W/mK.

The air is removed by this silicon to improve the heat dissipation.

The device is available with an aluminium heatsink that acts as a direct thermal interface to the cold plate. It is also available at 7kW and the company is developing a 22kW option.

Designs can be customised to requirements.





Data logger records multiple bus systems

A data logger from Saelig can record data from multiple bus systems simultaneously at data rates of up to 3Gbit/s.

Each logger comes with 20 HS-Can and Can-FD, eight RS232, two Flexray and eight Gigabit Ethernet interfaces.

The X2E Xoraya N4000 logger is equipped with an SFP+ interface for 10GbaseT and is housed in a rugged, hermetically sealed case with an active cooling system.

There are three slots for plug-in cards, which provide flexible configurations so it can be assembled or retrofitted according to requirements. An add-on board is available to equip the logger with 24 Lin connections.

Optional modules include LS-Can, HS-Can, Can-FD, Flexray, RS232, Lin, Ethernet, 100/1000-baseT1 (OABR), PSI5, and analogue signal inputs. Support for other bus systems is possible.

All data are logged with a precise, central timestamp offering 100ns resolution and saved either on the internal SSD or transferred via Ethernet to an external computer system or storage unit.

A built-in supercapacitor bridges any power fluctuations and provides the ability to shut the logger down safely during power failures.

The logger is based on the Zynq Ultra-Scale+ quadcore Arm Cortex-A53. For increased performance, the built-in Xilinx FPGA and ram can be exchanged for a more powerful FPGA module. The internal SSD memory can be expanded from the standard 240Gbyte to 1Tbyte.

Additional user-specific options can be obtained, from unique cable sets to corresponding custom installation racks for test vehicles. Software provided includes the Logger OS (Embedded Linux) with Xoraya Suite and an SDK for Microsoft Windows.

Connect, inform and manage

Samsung has introduced three automotive chips – the Exynos Auto T5123 for 5G connectivity, Exynos Auto V7 for in-vehicle infotainment, and the S2VPS01 power management IC (PMIC).

The T5123 is a 3GPP release-15 telematics control unit to bring fast and seamless 5G connectivity in standalone and non-standalone mode to connected cars. It delivers information to the vehicle in real time via high-speed download of up to 5.1Gbit/s and allows passengers to enjoy services such as high-definition content streaming and video calls.

To process large amounts of data transmitted and received through the 5G modem, it supports a PCI Express interface and a LPDDR4x mobile dram.

The unit comes with two Cortex-A55 CPU cores and built-in GNSS, and meets AEC-Q100.

The V7 integrates eight 1.5GHz Arm Cortex-A76 CPU cores and 11 Arm Mali G76 GPU cores.

The GPU comes in two groups, with three cores in the small domain for cluster display and AR-HUD, and eight in the big domain for central information display and others. Such separation lets the GPU support multiple systems simultaneously and brings safer operation as it stops one domain interfering with another.

It is equipped with an NPU for services such as virtual assistance that can process visual and audio data for face, speech or gesture recognition.

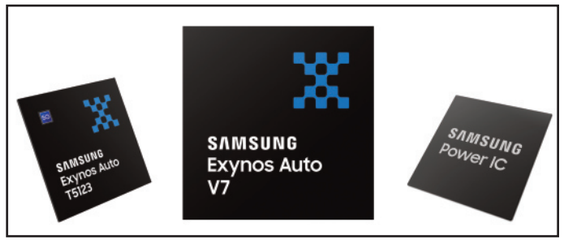
The device supports four displays and 12 camera inputs that provide information to assist drivers and passengers. Its imaging system provides bad pixel correction, dynamic range compression and geometric distortion correction for noiseless and distortion-free images for surround view and parking assistance. There are three HiFi 4 audio processors.

It has up to 32Gbyte of LPDDR4x memory capacity that offers bandwidth up to 68.3Gbyte/s.

The S2VPS01 is a PMIC designed for the Exynos Auto V9 and V7. It is produced under ISO 26262 and has achieved Asil-B certification.

The device regulates and rectifies the flow of electrical power, and is comprised of triple and dual-phase buck converters, and integrates a low-dropout regulator and real-time clock.

Protection functions include over voltage, under voltage, short circuit, over current, thermal shut down, clock monitoring and output stuck checks.



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