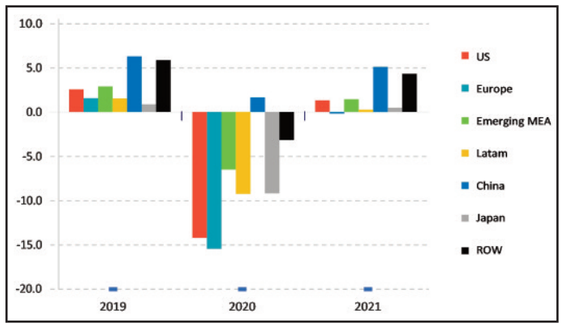
VEHICLE electronics

The monthly magazine for automotive electronics engineers

Covid-19 to disrupt automotive electronics until next year

The Covid-19 induced 2020 recession will disrupt automotive, consumer electronics, semiconductor and IT infrastructure businesses worldwide before recovery in 2021, according to analysis from Strategy Analytics.



Global real GDP growth: Deep XL U scenario %

The new scenarios indicate that the damage from the worst economic cycle since the Great Depression will cause consumer and B2B businesses to suffer starting with an economic plunge of over 7% in real GDP (33% annualised) in major industrial economies in Q2.

"The entire supply chain for digital products in our homes, our cars and associated with our mobile lifestyles will experience significant damage during this downturn that is likely to be felt globally over the next three to four quarters," said Harvey Cohen, president of Strategy Analytics. "Q3 is also expected to show a decline in real GDP of 3% (12% annualised) with no growth in sight until Q2 2021."

Ian Riches, VP of Strategy Analytics' automotive practice, added: "Globally, automotive sales and the consequent demand for automotive electronics are in free fall since March, with a potential decline of up to 25% for 2020 compared with 2019."

And David Kerr, SVP for wireless and broadband, said: "Global smartphone sales will tumble 23% in 2020 before seeing a modest recovery in 2021. The impact on 5G will be significant with services delayed in Europe and consumer appetite for expensive new 5G devices being much less healthy in North America and China. China's supply chain has recovered but consumer willingness to follow through on their plans to migrate to 5G devices and services is uncertain at best.

"One relative bright spot is network services. Shelter-in-home orders are increasing the demand for broadband activity although this will have little impact on operator revenues in the short term."

Issue 77
May 2020

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Alps helps STM design car audio IC

ST Microelectronics has worked with Japanese car audio equipment maker Alps Alpine to develop the FDA901 class-D audio amplifier IC.

The chip aims to contribute to creating multi-function, hi-fi car audio that fuses the high efficiency of class-D amps with the quality sound of STM's class-AB amps.

"For many years, Alpine Electronics has collaborated closely with STM and shared a wealth of sound-related knowledge," said Yukihiro Kobori, sound meister at Alps Alpine. "We are very pleased that STM's audio amplifier IC and our company's car audio technology and business have been able to grow together. We have worked with STM to design a class-D audio amplifier IC able to raise the level of audio quality across the entire car audio industry, while contributing to Alps Alpine's goal of developing the highest level of car audio."

The device has low residual noise and distortion ratio, flat frequency response through feedback technology, and low EMI levels. It delivers high-purity audio by reducing dropout of audio signals.

Equipped with a range of self-diagnostics and other functions to measure real-time speaker current and impedance, factors prized in the car audio market for diagnostics and to compensate for loudspeaker imperfections, the IC is in volume production.

Starting from the adoption in 39 models of Alpine's Big X aftermarket car-navigation systems to be released in the first half of 2020, the device will expand its market to several major car makers.

"In car audio, the amplifier IC is a key component that greatly affects sound quality," said Luca Celant, general manager at ST Microelectronics. "This new class-D audio amplifier sets a new bar for audio performance."

Yunqi e-bike eases social distancing



Hellobike has launched the Yunqi e-bike equipped with smart voice navigation to provide safer urban transportation and help citizens maintain social distancing. The feature can be activated through a Bluetooth connection and offer riders route directions while keeping their focus on the road.

While people in China are turning to shared mobility to maintain a safe physical distance to avoid the resurgence of Covid-19, e-bike is becoming a popular mode of transportation. The number of e-bike riders in Wuhan, for example, has experienced a tenfold jump compared with before the city was sealed off in January.

Using the Beidou navigation service, the Yunqi e-bike comes with a chipset that provides precise navigation and positioning. Technologies including Beidou, GPS and citywide wifi let staff pinpoint damaged e-bikes quickly with digital maps. It automatically disables the unlock function when the battery volume is below 30%, reducing the risk of malfunction or vandalism.

Pony.ai provides autonomous delivery service



Pony.ai launches autonomous delivery service

Autonomous driving technology company Pony.ai is partnering with ecommerce platform Yamibuy to provide an autonomous and contactless last-kilometre delivery service to its customers in Irvine, California.

The delivery service will provide additional capacity to address the surge of online orders triggered by the Covid-19 pandemic.

Running until mid-summer, Toyota-backed Pony.ai will use its all-electric, autonomous driving fleet to deliver packages and groceries from Yamibuy to its customers' doorsteps, helping to address the swell in demand while boosting delivery efficiency.

As the Covid-19 pandemic continues to strain communities' last-kilometre logistics services and essential businesses, the fleet offers a safe and convenient option.

Together with Yamibuy, Pony.ai continues to engage with the local community, providing critical goods delivery to fulfil residents' essential needs, in an effort to help residents stay indoors and flatten the curve.

Commercially, the partnership marks a major milestone for Pony.ai. It will be the first time that the Fremont-based firm has deployed its robotaxi fleet for goods delivery, demonstrating the versatility of its autonomous driving technology to transform mobility and logistics.

Pony.ai was the first company to launch a public-facing robotaxi service in California, which has been operating in Irvine since November 2019.

Imagination aids GPU acceleration in safety-critical use

Imagination Technologies' Open GL SC (safety-critical) 2.0 driver development for its automotive GPUs lets OEMs and tier-ones benefit from GPU acceleration in safety-critical applications.

Automotive applications such as digital dashboards, dials, clusters, cockpit domain controllers, surround-view displays and adas can now function with an added layer of protection.

The Open GL SC driver demo shows a dashboard with safety-critical elements running on existing automotive silicon.

"Safety is an increasingly important component in vehicles as they move towards greater autonomy," said Jamie Broome, senior director for Imagination's automotive business. "The creation of our new safety-critical driver recognises the often-overlooked aspect of certifiable software."

The driver has been developed in-house and is based on its product development lifecycle aligned to ISO 26262. It can be virtualised by leveraging the firm's HyperLane technology enabling it to be used alongside standard non-safety critical Open GL ES, Vulkan and Open CL drivers from Imagination.

The combination provides access to the full range of automotive APIs.

In addition, the driver will support the hardware safety and redundancy mechanisms in upcoming safety-critical GPUs from Imagination.

The driver is based on a published Khronos specification and is expected to pass the Khronos conformance process when available.

"The use of 3D graphics in cockpit domain controllers for dials, clusters and surround-view is on the rise and is increasingly important in defining the look and feel of the car," said James Hodgson, principal analyst at ABI Research. "Up to now, it has not been possible to make GPU drivers functionally safe, restricting the use of GPUs for safety-critical functions."

Automotive Grade Linux releases Itchy Icefish

Automotive Grade Linux (AGL) has announced the latest code release of the platform, UCB 9.0, also known as Itchy Icefish.

The UCB unified code base is open source software that can serve as a standard for infotainment, telematics and instrument cluster applications.

AGL members have already started integrating the UCB into production plans. The 2020 Subaru Outback and Subaru Legacy use open source software from the UCB, Mercedes-Benz Vans is using it as a foundation for an on-board operating system for its commercial vehicles, and Toyota's AGL-based infotainment system is in Toyota and Lexus vehicles globally.

Itchy Icefish includes an operating system, middleware and application framework.

Updates include over-the-air update for Ostree, application framework improvements including implementing Token Logic based security, and speech recognition using Alexa Auto SDK 2.0, improved speech API and voice-agent integration, and an open source version of display cards for speech recognition.

There have been audio enhancements to PipeWire and WirePlumber, and improved networking support and network settings, reworked Bluetooth APIs extended to PBap and map protocols.

HTML5 apps are security converted to using Token Logic; HTML5-only image is available using Web App Manager (WAM) and Chromium. HTML Demo apps are available for home screen, launcher, dashboard, settings, media player, mixer, HVAC and Chromium browser.

Additions to the instrument cluster include QML reference apps, steering wheel controls via Lin to IVI apps, and refreshed instrument cluster app that includes Can messages from the steering wheel and IVI.

Board support package updates include: Renesas RCar 3 BSPs; support for SanCloud BeagleBone Enhanced plus Automotive Cape support; i.MX6 using ETNaviv; and Raspberry Pi 4 support.



Karma develops in-house SiC inverters

Californian car maker Karma Automotive has developed two silicon carbide (SiC) inverters to enhance electric mobility charging.

The traction inverters were engineered in-house in collaboration with Pesla, the power electronic system laboratory at the University of Arkansas.



Karma SiC inverter for EVs

Engineered to improve efficiency and performance, the SiC traction inverters will be used in both future Karma vehicles and those of company partners. This flexible architecture design in a 400V system can be customised to fit various vehicle platforms and is available in 800V power levels to leverage higher voltage for fast charging.

The inverters will also be compatible with aircraft, train, agriculture and industrial applications. Prior to this, Karma also developed its own IGBT-based traction inverter that supports its 2020 Revero GT and GTS luxury electric vehicles.

Karma recently announced its E-Flex platform initiative, a series of versatile platforms that will offer electric vehicle mobility ranging from autonomously driven utility vans, to every-day driver vehicles, to high-performance supercars. The platform will allow manufacturers a fast-track into the electric vehicle market.

"Electrification represents a pivotal shift in the mobility industry, which is why Karma is focusing company efforts on our technology capabilities and for our partners," said Karma CEO Lance Zhou. "Our SiC inverters, coupled with our upcoming E-Flex platforms, are a testament to the revolutionary performance and efficiency we are proud to bring to the electric mobility industry."

Car makers demand FCC pledge before V2X

The US Alliance for Automotive Innovation has pledged to deploy at least five million V2X radios on vehicles and roadway infrastructure within the next five years as long as the Federal Communications Commission (FCC) maintains the entire 75MHz within the 5.9GHz safety spectrum for transportation safety, permitting cellular V2X (C-V2X) technology to operate alongside DSRC.

This represents a major turning point in realising the safety spectrum's full potential for transportation safety, and was made in an FCC filing by the alliance, which represents manufacturers producing nearly 99 per cent of US-sold cars and light trucks.

V2X communication technologies operate in the 5.9GHz safety spectrum band and allow vehicles to share real-time safety-critical information with each other and with infrastructure and other road users. These applications promise safety and societal benefits, including crash reductions that can save lives and provide economic, environmental and transport efficiencies.

"This represents more than 50 times the number of devices on the road today," said alliance president John Bozzella. "This commitment by automakers clearly shows these lifesaving technologies are ready and can be deployed in significant numbers in the next five years."

This commitment, which includes previous V2X deployments, shows the auto industry is aggressively working, along with other stakeholders, to increase use in the 5.9GHz band.

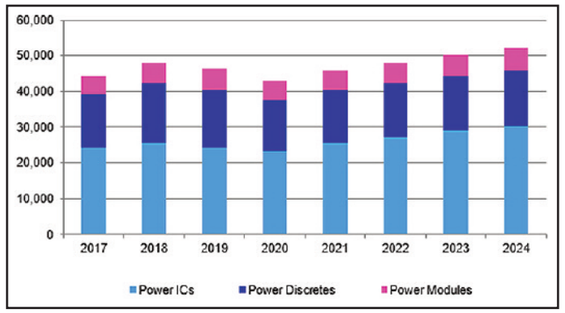
"Truly optimising the safety spectrum and achieving widespread deployment requires certainty that the entire 5.9GHz band will be available," said Bozzella.

Even in the face of regulatory uncertainty about the safety spectrum's future, the industry has made progress in developing and deploying V2X technologies in the USA. Prior to this commitment, vehicle manufacturers that had already deployed or announced V2X deployments accounted for more than 60 per cent of the automotive market share in the USA.

"Our commitment sends a clear message," said Bozzella.



Power semis face steep decline as Covid-19 bites



Power semiconductor revenues in $m

The global power semiconductor market is set for a steep decline in 2020 as demand for these components plunges from the key markets of smartphones and automotive electronics due to the Covid-19 crisis, according to market watcher Omdia.

The forecast is that the overall power semiconductor market will undergo a 6.9% decline in 2020, with revenue falling to $43.1bn in 2020, down from $46.3bn in 2019. The power semiconductor market consists of three segments – ICs, discretes and modules.

Discrete and module market revenue will decline by 10.6% in 2020. The previous forecast, issued in March, anticipated that the market would be flat in 2020, with a negligible 0.1% decline.

Power IC revenue in 2020 is set to decline 3.9% from 2019, a rare case of a two-year slip in that market. This forecast puts the power IC revenue for 2020 at $23.4bn, wiping out most of the market gains since 2016.

In the automotive market, vehicle sales have been plummeting due to shuttered dealerships and vehicle production line stoppages. Motor vehicle sales are likely to drop by a double-digit margin in 2020. On the other hand, rising electronic content in some automotive systems – such as adas and vehicle electrification – will moderate the power IC revenue declines to only 6%.

Discrete power semiconductor revenue will fall 10.7% this year, while power semiconductor modules will drop by 10.3%. Overall, the power discrete and module market will shed $2.4bn in revenue compared with 2019.

Looking at discrete power semiconductors in detail, the 2020 revenue decline is expected to come mainly from standard mosfet power transistors. Mosfet revenues are expected to decrease by around $1.4bn in 2020, down 16.5% year-on-year, before recovering somewhat in 2021. However, mosfet revenues will not return to 2018 levels until after 2024.

Bipolar power transistor revenues are forecast to decrease by around $170m in 2020, down 15% year-on-year, and IGBT power transistor revenues are anticipated to fall by around $110m in 2020, down 6.8% year-on-year. In contrast to discrete power transistors, rectifiers and thyristors will limit their declines to less than 1% in 2020.

Looking at power modules in detail, the 2020 revenue decline is expected to come mainly from standard IGBT power modules and IGBT-IPMs. Standard IGBT power module revenues are expected to decrease by around $300m in 2020, down by 11.1% year-on-year. IGBT-IPM revenues are forecast to decrease by around $270m in 2020, down 15.6% year-on-year, and mosfet module revenues are anticipated to decrease by around $33mn in 2020, down 11.9% year-on-year.

Power modules will not mount a major revenue recovery in 2021. Instead, Omdia predicts the market will continue to decline, a phenomenon that will continue in 2022 and 2023, before recovering in 2024.

Omdia is expecting a robust recovery for power semiconductors in 2021 based on strong demand for vehicles, as pent-up demand is unleashed after two years of dismal vehicle sales. It also anticipates that consumers will want to spend again on televisions, mobile device upgrades and other consumer goods once they are back to work.

This recovery depends on a gradual easing of restrictions in the developed world by mid-year, a manageable reoccurrence of the virus as the world moves into the next cold and flu season, and a successful vaccine rollout within 12 months.

The computer segment could help the market.

"Unlike power discretes, the computing and data-storage segment is the bright spot in the power IC market," said Kevin Anderson, senior research analyst for Omdia.

TRL sees voice control as future for infotainment

Voice control is the future of vehicle infotainment, according to the UK's Transport Research Laboratory (TRL), responding to evidence that shows driver distraction levels are much higher when using touch screen technologies.

The report – commissioned by IAM Roadsmart, FIA Road Safety and Rees Jeffreys Road Fund – looks at the impacts of in-vehicle infotainment such as Android Auto and Apple CarPlay on driving performance.

Evidence shows that driver distraction levels are much higher when using touch screen technologies compared with voice activated systems. However, further research is necessary to steer the use of spoken instructions as the safest method for future in-car control.

With driver distraction estimated to be a factor in up to 30% of vehicle collisions across Europe, the improved safety of in-vehicle infotainment systems is a must if this number is to be decreased. By improving voice-activated systems through the use of such technology as conversational artificial intelligence (AI), it is possible that infotainment systems could become less distracting for drivers.

This call for voice-activated systems is supported by the development of conversational AI, which enables speech interfaces to operate at a complex level. Currently, voice control systems only understand a set of key commands. Thanks to conversational AI, this will widen to include all forms of dialogue to enable a natural interaction.

"The results of this study clearly show that touch control infotainment systems are highly distracting to drivers, far more so than voice activated systems," said Neale Kinnear, head of behavioural science at TRL. "However, even current voice control systems increase drivers' reaction times and remains a concern for road safety. This is why TRL is recommending that we put our efforts into developing a framework for testing and improving the human factors of such systems."

This, he said, included improving voice activation as a method of control, as this could reduce the workload on a driver thanks to innovations in conversational AI. TRL would like to see better safety standards around infotainment, not just by their definition, but also through the harmonisation of standards across the entire transport sector.

"Driver distraction is widely recognised as an important road safety issue," said Kinnear. "The more attention a driver diverts away from the main driving task, the more their driving behaviour will be negatively affected. To improve the use and safety impact of in-vehicle technologies, an agreed framework for testing is required to which system manufacturers can demonstrate their safe use before bringing to market. Alongside improvements in voice activated systems, there is opportunity to improve systems so that we don't make the driving task more complicated in the future."



Speak don't touch: Voice activation is safer than touch control

R&S and TE collaborate on Automotive Ethernet testing

Rohde & Schwarz and TE Connectivity are co-operating on testing Automotive Ethernet cables and connectors.

They have tested a communication link, using shielded twisted pair (STP) cables and TE's Matenet data connector, for compliance with the One-Pair Ethernet (Open) Alliance committee group nine spec for 1000baseT1.

Automotive Ethernet for in-vehicle communications offers speeds up to 10Gbit/s. For data speeds up to 1Gbit/s (1000baseT1), the link can run on unshielded twisted pair (UTP) cable.

However, for speeds above 1Gbit/s, EMI becomes increasingly critical and can threaten the integrity of other communications in the vehicle.

Therefore, the Open Alliance is focusing on shielded cable to reduce emissions as the industry moves towards faster speeds such as 2.5Gbit/s, 5Gbit/s or 10GbaseT1.

R&S helped TE verify the development and manufacturing of the cables and connector components used in automotive. The compliance tests were performed on STP cables with Matenet terminals and connectors using the R&S ZNB vector network analyser with the integrated in-situ de-embedding function from Ataitec.

"This test specification can be a challenging task for many engineers," said Nik Dimitrakopoulos, responsible for Automotive Ethernet and infotainment at Rohde & Schwarz.

Andreas Engel, senior manager at TE, added: "Our customers demand the highest robustness and reliability and it is vital that we can demonstrate compliance with the most stringent test specifications for signal integrity and electromagnetic compatibility."



R&S ZNB vector network analyser



Regulus Cyber GPS hacking experiment

Regulus helps Harman guard against GPS hacks

Anti-virus firm Regulus Cyber is working with Harman on software-based cyber security designed to protect GPS against potential threats.

This will become part of Harman Shield, the company's offering for risk management to vehicle manufacturers and mobility companies.

Regulus created anti-virus software to protect satellite navigation and timing across a wide range of applications, including automotive, mobile, IoT and critical infrastructure.

"We're seeing our OEM customers expand into the digital and mobility spaces, offering added-value services to consumers by leveraging connectivity and mobile applications," said Asaf Atzmon, vice president of Harman. "Through Harman Shield, we offer full visibility, analytics and risk management capabilities into cyber threats, and Regulus Pyramid GNSS complements our offering with another layer of protection against GPS hacking."

Pyramid GNSS is software that uses machine learning to detect spoofing and defend any GNSS receiver, device or chipset against it, ensuring the security and reliability that are essential to safe and accurate navigation. GPS spoofing attacks are becoming more common and are often very difficult to detect and protect against.

It uses a combination of patented algorithms developed over years of spoofing experiments to protect against attacks at firmware, operating system or application levels.

Founded in 2016, Regulus is based in Haifa, Israel, and is backed by SPDG Ventures, BTOV Partners, Sierra Ventures, Canaan Partners Israel, Technion Drive Accelerator and F2 Capital.

Shouqi and Alibaba look to 5G edge computing

A cooperative pilot project between Shouqi Limousine & Chauffeur and Alibaba Cloud has been initiated to explore 5G edge computing for online ride-hailing mobile services.

The project will jointly explore the application and expansion of edge computing in transportation under 5G and promote the development and upgrade of the public transport industry.

The network speed of 5G is significantly greater than that of 4G, up to ten times faster, and the latency of 5G has reduced to milliseconds, one tenth that of 4G.

The cooperation between Chinese online ride-hailing firm Shouqi and Alibaba aims to promote the further development of internet of vehicles (IoV) projects and realise the innovation of 5G application modes.

With 5G edge computing, the perception, transmission, handling and response of road traffic condition during the driving process will be transferred to Alibaba Cloud's ENS edge node service for processing.

This should let Shouqi meet the real-time demand of perception analysis for feedback decisions when driving.

In the near future, more data will be directly analysed and processed outside the server on the terminal side with edge computing.

Shouqi reached a strategic cooperation with Baidu in 2017 to focus on promoting the commercial operation of autonomous driving cars and the IoV. This led to the first vehicle intelligent hardware system launched by Apollo Duer OS under the Baidu-Apollo IoV agreement.

Shouqi has also cooperated with Carnet Cloud to develop equipment and safety products for IoV.



Shouqi and Alibaba explore 5G edge computing

C2A partners Autosar to develop cyber security

Automotive cyber-security firm C2A Security has formed a development partnership with the Autosar consortium in what is said to mark the first and only time an Israeli start-up has partnered with the alliance.

As a development partner, C2A will collaborate with all partners to define cyber-security infrastructure for security sensors and modules, ultimately working towards new Autosar standards for improved vehicle performance, safety and cyber security.

Since 2003, the Autosar consortium has increased the exchangeability of software modules across all vehicle platforms and opened the industry standard for integrated complex electrical and electronic architectures.

"Autosar's and C2A's missions are in alignment," said C2A chief product and marketing officer Nathaniel Meron. "Both promote visibility, standardisation and market neutrality with the aim of making vehicles of today and tomorrow safer. With automotive software and networks becoming more complex and interconnected by the day, C2A is honoured to contribute to the development of a cyber secure ecosystem in collaboration with our Autosar colleagues."

The development partnership will grant C2A Security the right to use Autosar technology and access to related intellectual property of other Autosar partners, which will enable C2A to take further steps in the development of its cyber-security products and cyber-security lifecycle management platform.

All C2A products can be integrated into Autosar projects following the Autosar methodology.

Infineon completes Cypress takeover

Infineon has completed its €9bn takeover of Cypress Semiconductor.

"Together, we offer our customers the industry's most comprehensive portfolio for linking the real with the digital world and shaping digitalisation, one of the most important global trends," said Infineon CEO Reinhard Ploss.

Cypress brings MCUs, connectivity components, software ecosystems and memories to Infineon.

Mobiledge X and Solace enhance mobility services

To help car makers offer hyper-personalised mobility services that enhance safety and convenience for drivers, edge computing firm Mobiledge X has partnered Solace, an enabler of real-time event-driven data streaming for enterprise computing, IoT and mobile applications.

Collaborative and intelligent transport networks hinge on the efficient, reliable and real-time distribution of data between cars, other road users, infrastructure and applications. Solace says it can meet that need with its PubSub+ event streaming and management platform used by vehicle manufacturers such as Renault and PSA to stream events across the enterprise.

Mobiledge X's edge-cloud technology leverages 5G connectivity to provide the critical connectivity layer required to establish reliable and real-time vehicle, infrastructure and mobile device connections. By integrating the real-time routing capabilities that PubSub+ offers into the connectivity layer, Solace and Mobiledge X are unlocking the potential to deploy mobility services in and around vehicles.

"Leading automakers are striving to transform their business from selling vehicles to providing hyper-personalised mobility services, and such services hinge on cellular-to-vehicle-to-everything connectivity that is reliable, robust and responsive with minimal latency," said Eric Braun, chief commercial officer at Mobiledge X. "Our platform intelligently places and executes workloads so vehicles can be continuously connected via 5G to edge-based services for maximum safety and digitally transformed passenger experiences. Solace's PubSub+ ensures the immediate and intelligent routing of safety-critical data, alerts and highly customised content."

End-to-end network latency is below 10ms and end-to-end business service latency under 50ms.

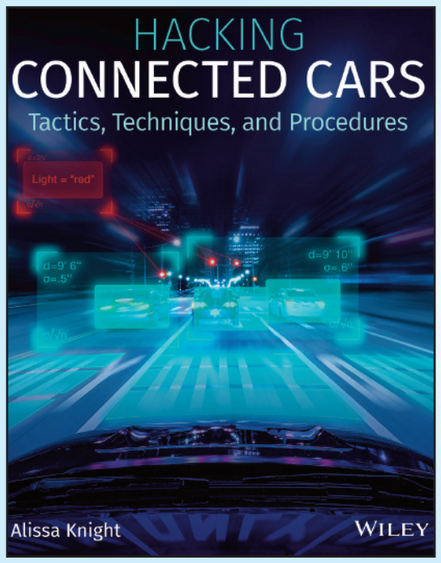
The joint offering can connect all modes of transportation and other assets across fleets, carriers, borders, agencies and ecosystems.

Trusted security in and across a global, multi-operator network reduces the enterprise's requirements in a shared responsibility model.

"PubSub+ has proven ability to meet the demand of high-volume connected vehicle initiatives that link tens of millions of vehicles with cloud and on-premises systems," said Paul Fitzpatrick, Solace's business development officer.

One example of a safety-critical system that could be deployed using this is a vulnerable road user warning system.

How to keep vehicles secure



Because of consumer demand for always-on connectivity, and a push to leverage technology to decrease traffic congestion by connecting vehicles to smart cities, Wiley has published "Hacking Connected Cars: Tactics, Techniques and Procedures".

The book provides guidance and preventative tactics to keep vehicles secure as in-vehicle networks suddenly become reachable from anywhere.

In it, author Alissa Knight – a veteran of risk management and penetration testing of IoT devices and connected cars – deconstructs the tactics, techniques and procedures used for risk analysis and exploitation of vulnerabilities in connected cars.

Written for cyber-security professionals who may not be experts in vehicle mechatronics, as well as security practitioners, researchers and vendors, the book provides a complete reference to mitigate vulnerabilities and keep connected cars safe without sacrificing connectivity.



MCity digital twin from RFPro

RFPro creates digital twin of MCity test facility

Simulation software specialist RFPro has created a digital twin of MCity, a purpose-built facility at the University of Michigan for testing connected and automated vehicles and technologies under controlled, realistic conditions.

The digital twin enables vehicle manufacturers and technology suppliers to accelerate development using simulation.

This should allow simulated tests that correlate with real world experiments, meaning users can prepare ahead of each visit to the real-world site in simulation. Tests at the real-world track can also be used to validate the simulated tests, ensuring the large-scale testing that can be achieved in simulation is accurate and reliable.

Like its real-world counterpart, the digital twin contains different roadside objects and materials to ensure accurate simulation of radar, lidar and camera sensors.

RFPro used survey-grade lidar equipment to capture a digital copy of the environment accurate to less than 1mm.

Road layouts, lanes and junctions are described inside in OpenDrive, IPG Road5 and Sumo formats.

As these are the three main industry standards for road network descriptions, it means the digital twin is compatible with all major vehicle and modelling tools.

Situated on a 32-acre site at the University of Michigan and with more than 16 acres of road and traffic infrastructure, M-City is one of the first purpose-built autonomous-focused proving grounds. The outdoor laboratory simulates the broad range of complexities vehicles may encounter on roads in urban and suburban use.

"We are excited that RFPro is offering a digital twin of our facility as we believe it will bring significant value to our researchers and industry partners," said Huei Peng, professor of mechanical engineering at the University of Michigan. "The MCity test facility was purpose-built for safe, repeatable testing of connected and automated vehicles [CAVs] and technologies in a controlled environment. The development of CAVs is safer, faster and cheaper by strategically combining controlled tests and simulations, rather than relying too heavily on public road testing."

Via gets ISO 26262 thumbs up

Via Technologies has received ISO 26262 process audit certification for the functional safety of electrical and electronic systems in commercial vehicles from third-party testing, inspection and certification company SGS-TÜV Saar.

This certification lets Via develop automotive-grade devices that meet Asil-D safety standards.

"SGS is an independent testing organisation that operated according to the most stringent inspection standards in the market," said Jack Kuo, vice president of SGS in Taiwan. "Via has demonstrated its compliance with the principles and processes of functional safety as it relates to automotive."

The testing processes demonstrated that functional safety standards for the automotive industry were implemented in the development process and hardware design.

"Safety is our number one priority in the development of boards and systems for the automotive industry," said Richard Brown, vice president at Via.

SENSORS

Handing over control

Enda Nicholl discusses how a dual anisotropic magneto-resistive motor position sensor can help with safety critical applications

Vehicle Electronics

The increased emphasis to improve vehicle safety in recent years has resulted in the welcome advancement and introduction of active adas to complement the traditional passive systems reliant on airbag deployment for driver and passenger safety. These emerging systems are intended to initially aid – but in the longer term replace – the driver's vehicle manoeuvre decision making in safety critical situations.

These technology advancements are also leading the way to the transition to semi and fully autonomous driving.

Replacing the driver's decision making with ECUs and replacing the steering and brake manoeuvring of the vehicle with actuators are shifting responsibility away from the driver to the sensors, ECUs and electrical actuators.

This trend is leading to the development of more reliable, intelligent, higher performance and redundant electrical actuators that need to comply with the ISO 26262 functional safety standard. This is a risk-based safety standard, where the risk of hazardous operational situations is qualitatively assessed, and safety measures are designed into the components and system to avoid or control systematic failures and to detect or control random hardware failures or mitigate their effects.

These actuator systems generally use brushless DC (BLDC) motor drives and, as these systems are safety critical, the designers must design the hardware and software such that the system complies with the highest automotive safety integrity level, Asil D.

Commutation and control

BLDC motors, as the name suggests, have no brush contacts, and motor position sensors (MPSs) are needed to measure the relative position between the stator and rotor to ensure the correct stator coil energising sequence. This is particularly critical at start-up when there is no back EMF available and it is impossible for the microcontroller to determine the relative rotor and stator positions.

Traditionally, block commutation (see Fig. 1a), which is comprised of three Hall switches, has been used to indicate the rotor position in BLDC motors. The demands to improve performance and, in particular, reduce noise, vibration and harshness (NVH) and improve running efficiency of BLDC motor drives – including EPS systems – is resulting in a move away from block commutation to sine commutation control.

The Hall switches can be replaced with a magneto-resistive (MR) angle sensor positioned in front of a bipole magnet mounted onto the end of the motor shaft, see Fig. 1b. It is also typical for the MPS to be mounted onto the ECU assembly and for the ECU to be integrated into the motor casing and positioned at the end of the motor shaft.

Functional safety

ISO 26262 was introduced in 2011 as a safety standard to address the possible hazards caused by electrical safety-related system failures and has

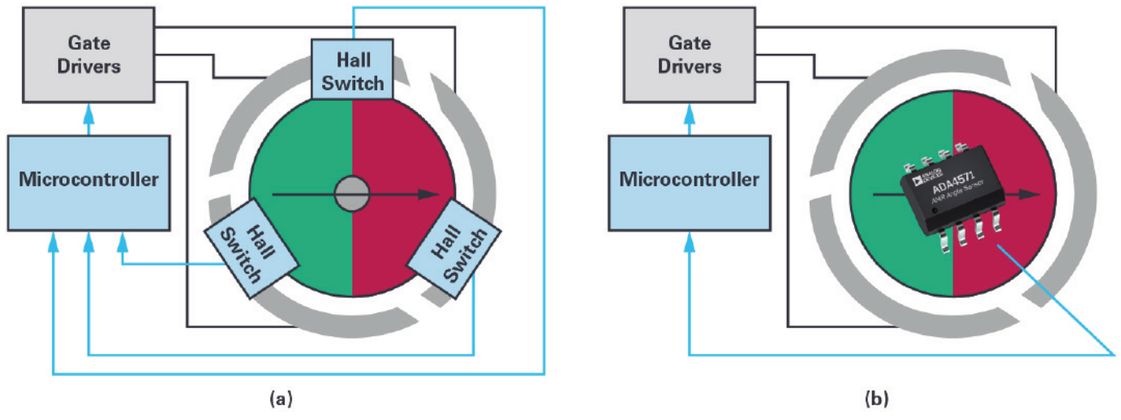


Fig. 1: (a) BLDC block commutation control and (b) BLDC sine commutation control

subsequently been replaced with a 2018 edition.

A safety and risk analysis must be carried out on the system to determine the Asil of the system. The Asil rating is established by reviewing the system's potential hazards during operation in terms of severity, exposure and controllability, see Fig. 2.

For example, following a risk and hazard analysis on an EPS system, it will be concluded that severe events such as steering blocking and self-steering land in the Asil D category because of the severity, controllability and exposure of these events. Similarly, for upcoming electrical braking systems, the same logic applies to the severity of uncontrollable events such as brake blocking or self-braking.

Following on with the EPS or braking system examples, the Asil D system rating can be achieved through subsystem decomposition as shown in Figs. 3a, 3b and 3c.

It is not required that each system component be developed to Asil D standards and processes to enable Asil D system compliance; however, the overall system must fulfil the requirements when viewed at system level and can incorporate QM, Asil A, B, C or D level subcomponents as part of the system.

QM stands for quality management and means the risk associated with a hazardous event is not unreasonable and does not therefore require safety measures in accordance with ISO 26262.

The system decomposition should also ensure a sufficient independence and take into account the possibility of dependent or common cause failures.

Decreased Controllability

ASIL (Automotive Safety Integrity Level)		Controllability (C)			
Severity (S)	Expopsure (E)	C0 Controllable in General	C1 Simply Controllable	C2 Normally Controllable	C3 Difficult to Control or Uncontrollable
S0 No Injuries	–	QM			
S1 Light and Moderate Injuries	E0 – Unusual	QM			
	E1 – Very Low Probability	QM			
	E2 – Low Probability	QM			
	E3 – Medium Probability	QM			ASIL A
	E0 – High Probability	QM		ASIL A	ASIL B
S2 Severe Injuries, Possibly Life Threatening	E0 – Unusual	QM			
	E1 – Very Low Probability	QM			
	E2 – Low Probability	QM			ASIL A
	E3 – Medium Probability	QM		ASIL A	ASIL B
	E0 – High Probability	QM	ASIL A	ASIL B	ASIL C
S3 Life Threatening or Fatal Injuries	E0 – Unusual	QM			
	E1 – Very Low Probability	QM			ASIL A
	E2 – Low Probability	QM		ASIL A	ASIL B
	E3 – Medium Probability	QM	ASIL A	ASIL B	ASIL C
	E0 – High Probability	QM	ASIL B	ASIL C	ASIL D

Increased Severity

Fig. 2: ISO 26262 Asil rating matrix

EPS topology

A typical EPS system topology is outlined in Fig. 4. The EPS ECU calculates the assisting power needed based on the steering torque being applied to the steering wheel by the driver, the steering wheel position and the vehicle's speed. The EPS motor rotates a steering gear with an applied force that reduces the torque required from the driver to manoeuvre the steering wheel.

The motor shaft position angle combined with phase current measurement information is used for the commutation and control of the EPS motor drive. The basic typical EPS motor control loop is outlined in Fig. 5.

The torque assistance level required varies depending on the driving conditions and is determined by the wheel speed sensors and the torque sensor, which measures the torque applied to the steering wheel by the driver or by the motor actuator in driverless cars. The microcontroller then uses the motor shaft position data in combination with the phase current data to control the current loads supplied to the motor that provide the needed assistance.

Phase current sensors

An MPS fault or failure could potentially cause or contribute to a severe system failure such as steering lock or self-steering, and for that reason the MPS is a critical component in the EPS

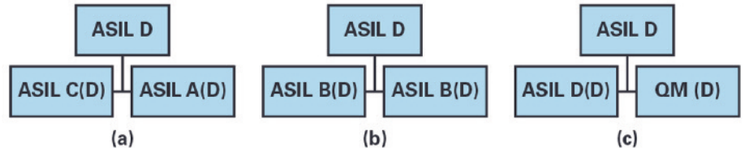


Fig. 3: Asil decomposition scheme for an Asil D system

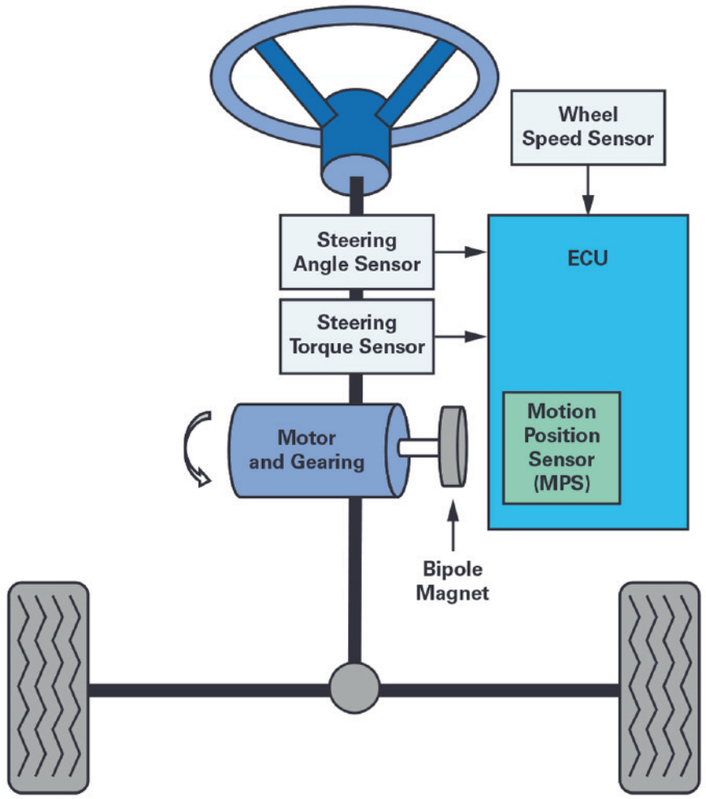


Fig. 4: Typical EPS topology

system. It is therefore essential that the system has comprehensive diagnostic coverage of sensor faults and redundancy built in to ensure continued functionality in the event of an MPS error or fault and ensure severe system failures cannot occur or, in the event an error does occur, that the system fails in a safe manner.

Current sense amplifiers are typically used for the indirect precision measurement of the motor load and normally applied to two of the three motor phases, thus enabling additional diagnostic information that can be used as part of the overall system safety case.

In addition, high precision motor position and phase current measurements allow for improvements in the EPS motor control performance that at a system level result in a very efficient, quiet and smooth steering feel, improving the overall driver experience, and are therefore critical components in the system.

Motor control

Different approaches can be taken to achieve Asil D compliance in an EPS or other safety critical motor control application. The following example explains a dual anisotropic magneto-resistive (AMR) motor position sensor combined with a current sense amplifier could be integrated into such a system and provide the performance and redundancy needed to achieve Asil D compliance at a system level.

In Fig. 6, the dual AMR sensor is complemented with an additional sensor based on a different technology, for example, Hall, GMR or TMR. The dual AMR sensor is used as the primary (high precision) sensing channel, and the secondary alternate sensor technology channel serves three purposes:

- Enable the provision of a two-out-of-three (2oo3) comparison to validate if there is a fault with one of the sensor channels when combined with other system inputs.
- Provide position feedback in the unlikely event that both AMR channels fail.
- Provide the 360° quadrant

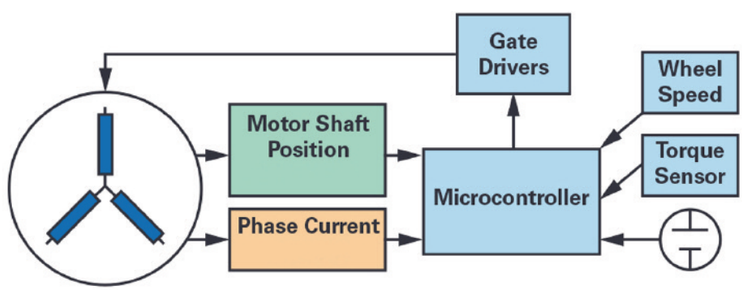
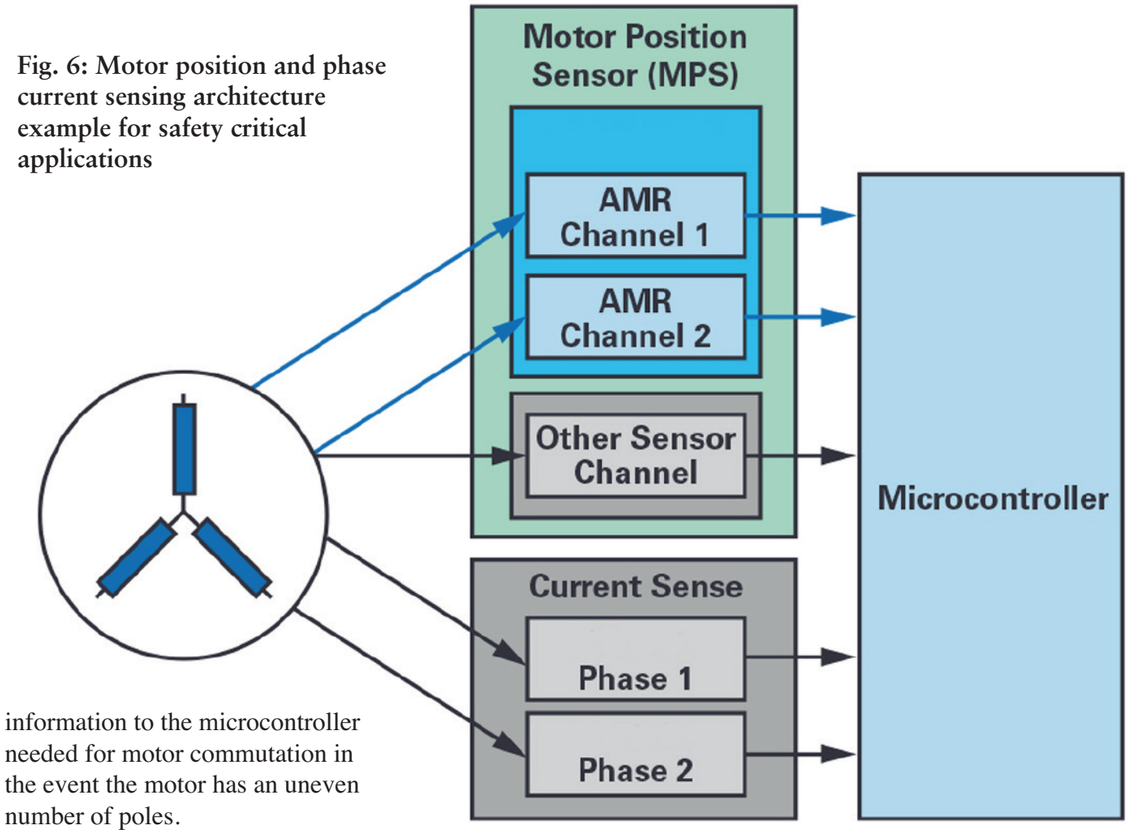


Fig. 5: Typical EPS motor control loop

Fig. 6: Motor position and phase current sensing architecture example for safety critical applications



information to the microcontroller needed for motor commutation in the event the motor has an uneven number of poles.

The precision angle measurement will continue to be provided by both channels of the dual AMR sensor.

Additional system diagnostics such as motor load and shaft position can be indirectly inferred in a dynamic state (back EMF) from the precise phase current sense amplifier.

Looking at all the possible sensor failure modes in this sensor architecture example, there should always be two position sensor inputs available for a plausibility check. Even in the unlikely and extreme case of both AMR channels failing simultaneously due to a common cause failure, it is still possible to use the degraded position sense information from the auxiliary sensor channel and cross check this with the back EMF information from the current sensors in the dynamic state and ensure continued basic system functionality.

This system-level diagnostics capability would then ensure a severe failure mode could not occur and the system fulfils Asil D compliance. The system could then be safely powered down, or moved to limp home mode, and returned to the dealer for repair.

Summary

The introduction of adas to improve automotive safety, combined with the emergence of fully and semi-autonomous vehicles, is driving the demand for more reliable, intelligent, higher performance and redundant electrical actuators that comply with ISO 26262.

Motor shaft position and phase current sensing products are available that not only meet the improved performance demands for smooth and efficient motor control, but also provide the redundancy needed to achieve high Asil requirements in these safety critical applications such as EPS or braking systems.



Enda Nicholl is a strategic marketing manager at Analog Devices

SENSORS



MAKE YOUR SEAT

Dieter Verstreken on how PCB-less sensors can raise integration and improve reliability to improve comfort in car seats

Comfort and safety often go together, particularly in an automotive application. Many manufacturers now offer motorised seat adjustments for the driver and front passenger, even in mid-range specifications; some even offer motorised rear-seat adjustment. Electrification of this kind offers perceivable value to a vehicle and can differentiate a marque in a very competitive market.

The level of electrification can vary, of course, ranging from a simple forward-backwards adjustment requiring just one motor, to full featured adjustment using nine motors or more in one seat.

Although the heavy lifting is handled by a motor, the actuation is still normally manual, meaning the driver or passenger must press a switch to activate the motor that moves the seat. Increasingly, vehicles now make the adjustment automatically for the driver based on, typically, which key they are using.

In the near future, the car may use other information to make that adjustment, such as a vision system that recognises the driver's face or other defining features.

From the consumer's point of view, it may appear to be a relatively small step from manually actuated adjustment to having the vehicle automatically move a seat into a programmed position. However, an engineer will immediately identify that this removes the crucial link in the feedback chain; the person. To implement automatic adjustment, it is necessary to employ some other form of feedback to provide the positional data to the ECU controlling the motor.

There are a number of ways this can be achieved using sensors and they would generally fall under the definition of either relative or absolute positional data. It would be easy to over-engineer given the many types of sensors now available on the market, but relative position is already emerging as the most appropriate.

This can be implemented with a reasonably simple sensor that encodes the rotation of the motor's shaft. Each full resolution will correspond to a known distance of travel for the respective seat part, such as the height of the seat or the angle of the backrest. Measuring the rotations will provide a difference in position relative to the starting point; the ECU simply needs to know the original position, the unit of distance and the absolute travel.

The latter two will be fixed by design, while the position will be set at origin when the car is manufactured and first powered up, and then updated each time the chair part is moved either manually by the driver or passenger or automatically by the ECU.

Position encoding

Encoding the rotation of the motor shaft requires a sensor that can meet a number of requirements. As this is an automotive application, it needs to be automotive qualified, of course, which means being able to



Electrification is allowing more automatic seat adjustment

withstand environmental extremes such as vibration and temperature, as well as electrical extremes including EMI and regular spikes and surges. In this application, it will also need to be compact and affordable.

For reliability reasons, a contactless method would provide further advantages as there would be no wear on the sensing element.

The Hall Effect is perhaps the most universally successful form of contactless sensing used today and examples of its application can be found in all vertical markets. The Hall Effect is a measurable voltage difference produced across a conductor, which is proportional to a magnetic field applied in a plane perpendicular to the flow of current.

There are various levels of integration that can be achieved with Hall Effect sensors and in many applications the physical space needed may not be high among the key criteria.

This means the sensor can be mounted on a PCB, along with any additional components that may be required, such as an analogue-to-digital converter. In seat positioning, space is very much an issue, as the available space is limited, particularly if multiple motors are used.

PCB-less

In this case, the ideal would be to provide more integration in a single package and many Hall Effect sensors do indeed deliver this. Putting all the functionally important features into the same package raises the level of abstraction and reduces the overall design effort.

If this integration is taken to its logical conclusion, there would be no need for a PCB at all, giving manufacturers the simplest and smallest possible method, as illustrated by the functional block diagram in Fig. 1.

The mixed-signal cmos platform allows for the integration of the Hall plate sensing element, a voltage regulator, digital control and eeprom non-volatile storage. The Schmitt trigger operational amplifier provides the analogue-to-digital conversion, and the output operates as a latching signal, letting the ECU know when the polarity of the magnet on the motor shaft has changed.

This is all the information the ECU needs to count revolutions and therefore calculate the relative position of the seat part being adjusted.

Integrated passive components include a decoupling capacitor and a simulated resistor.

By integrating it in the same package, the decoupling capacitor can be physically located closer to the sensitive silicon elements, thereby giving better protection from electrical noise. A resistive element is necessary to match the output impedance of the sensor to the ECU's input.

With other sensors, these

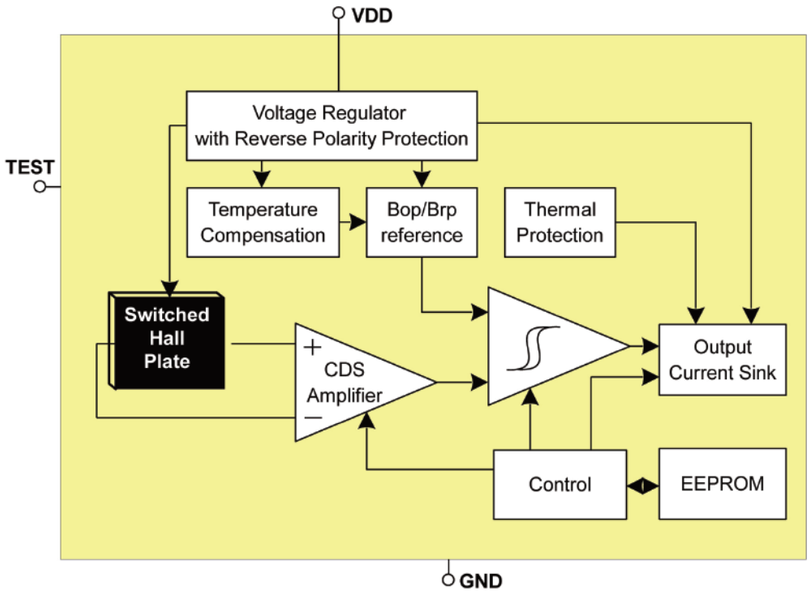


Fig. 1: Functional block diagram

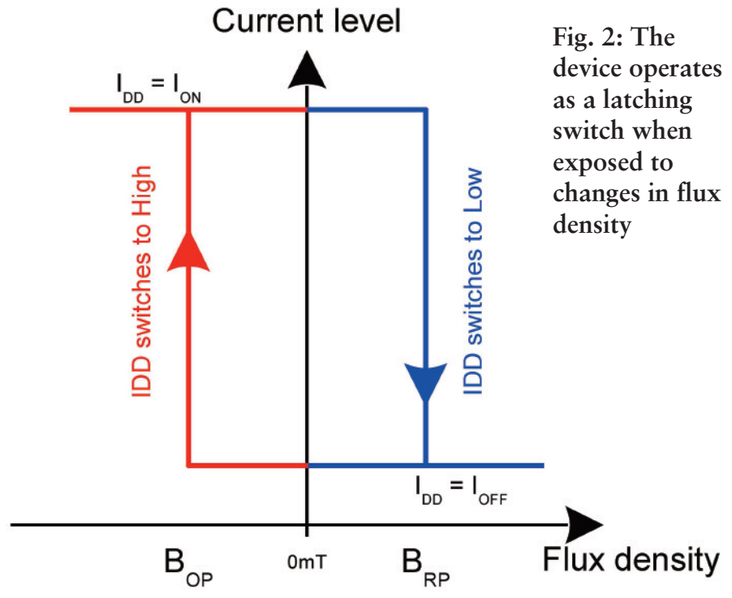


Fig. 2: The device operates as a latching switch when exposed to changes in flux density

passives are normally external, which necessitates the use of a PCB, but being fully integrated means manufacturers can avoid the use of a PCB altogether and mount the sensor directly to the seat's structure.

This provides a significant saving in terms of the bill of materials, design effort and manufacturing costs, as well as improving reliability by reducing the system component count from five – PCB, sensor, decoupling capacitor, resistor and connector – to just one.

As a latching switch, the device outputs a square wave (Fig. 2) based on the magnet flux field strength. The core employs an offset cancellation system and uses temperature coefficients to compensate for the change in magnetic field strength that happens naturally when they are exposed to temperature variations. This means manufacturers can use the most cost-efficient (typically ferrite) magnets in their designs.

The integrated simulated resistor is implemented using technology that emulates the resistor, rather than using an external, discrete resistor, as this simplifies the manufacturing and testing procedure. The emulated resistor behaves in exactly the same way as a conventional discrete device.

The device also integrates a voltage regulator that operates from 3.8 to 16V, with reverse-voltage protection so there's no requirement to include a diode on the input supply. With a maximum operating junction temperature of +165˚C, thermal management extends to limiting the supply current if the junction temperature exceeds +190˚C. Normal operation is reinstated when the junction temperature drops to +180˚C. Current is also limited if the supply voltage exceeds 16.8V.

Fig. 3 shows how this is used in a typical application.

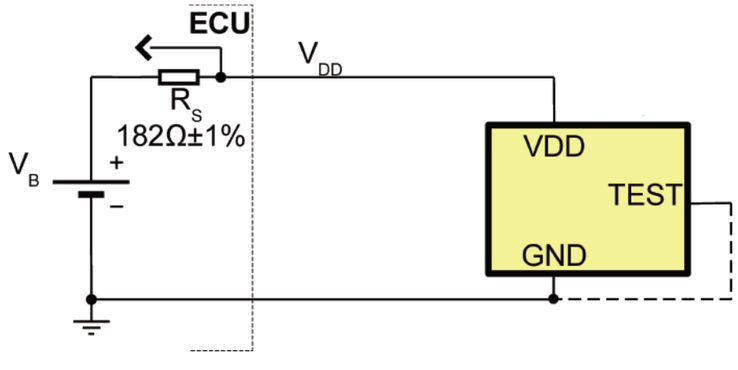


Fig. 3: Typical application

Conclusion

As the electrification of vehicles continues, drivers and passengers can expect to enjoy higher levels of comfort, some of which will be implemented in the form of motorised seat adjustment. This is quickly evolving into automatic adjustment, which requires sensors to provide the crucial link in the control feedback loop. A Hall Effect switch can form a PCB-less way to meet the needs of this application, enabling more integration with fewer components.



Dieter Verstreken is a product line manager at Melexis

NEURAL NETWORKS

THINK WHAT YOU SEE

A look at how one company is using neural network technology to improve object classification and pedestrian recognition

Artificial intelligence and convolutional neural network (CNN) technology has made the automatic detection of a range of objects possible. Still, it will never be possible to eliminate erroneous classifications fully; one reason is the reliability of automatic image processing must continue to improve.

The correct classification of objects is a matter of life or death in autonomous driving, and this requires a deeper understanding of decision-making processes within the neural networks. Gaining a better grasp of these mechanisms helps reduce misclassification and comply with the ISO 26262 and ISO/PAS 21448 safety standards for the reduction of, for example, unknown or unsafe scenarios.

That's why, as part of its research activities, Arrk Engineering has developed the foundations of a framework for better understanding how CNNs work, and ultimately improving their object classification capabilities. This framework makes it easier to identify and eliminate vulnerabilities in a CNN, thus reducing the risk of errors and accidents caused by incorrect classifications.

There is a strong push in the automotive industry to develop better adas with the help of, for instance, hardware with more efficient and robust sensors or more powerful algorithms.

In the ample research being conducted in this area, the recognition rate in automatic image processing is of central importance.

"What's key to autonomous driving is that the algorithms for object recognition work fast and yield a minimal error rate," said Václav Diviš, senior engineer at Arrk Engineering. "But it will only be possible to develop optimal safety features for autonomous driving once we have understood neural networks down to the last detail. The ISO 26262 and ISO/PAS 21448 standards provide the general framework for this, and it will be especially important to ensure the development processes and evaluation metrics are uniform."

To achieve this goal, Arrk has established an evaluation framework for machine learning in the form of software as part of its research activities. This software should enable deeper insight into the recognition process of neural networks. From there, it should be possible to optimise algorithms and improve automatic object recognition.

The experiment also served to gain a better understanding of how neural networks work.

Training

The first step was to select a reliable generative adversarial network (GAN) architecture, consisting of two neural networks – one generator and one discriminator – to provide a basis for the framework and to augment the dataset. In this phase, the used dataset comprised more than 1000 photos of pedestrians.

"Additional images were generated using the GAN to extend the dataset," Diviš said. "The GAN's generator synthesised an image and the discriminator assessed the quality

What are ISO 26262 and ISO/PAS 21448?

ISO 26262 is an automotive standard that relates to functional safety. It classifies measures to counteract potential risks posed by vehicle features according to so-called automotive safety integrity levels (Asils).

The five-point scale (QM, A, B, C, D) defines various process requirements for the development of the product.

With Asil QM, standard quality assurance in the development process is sufficient, while Asil A requires additional risk reduction measures through monitoring diagnostics and plausibility functions. Products with the greatest potential risk – and thus the highest safety requirements – are classified as Asil D.

ISO/PAS 21448 imposes additional guidelines for design, verification and validation measures in autonomous driving that are required for achieving safety of the intended functionality (sotif). Proper situational awareness, derived from complex sensors, and the associated processing algorithms play a key role here.

Automatic image recognition is only capable of identifying objects such as people with a certain degree of probability; errors in object recognition pose a major safety risk in autonomous driving



of this image. The interaction between these two neural networks allows us to extract the features from the original objects, generate new image and extend the original dataset relatively easily."

Then, the classification network was trained on the original dataset and the test results were evaluated. To achieve the best possible results, the latest architectures were used for all elements in the experiment.

"The generalisation of the object represents a challenge in image processing, said Diviš. "The basic question is: What defines pedestrian? This can be easily answered by humans, since we generalise inductively. Neural networks, on the other hand, work



Engineers have developed the foundations of a framework to better understand how CNNs recognise images, and ultimately improve their ability to do so, with the aim to increase the probability that the system will detect a pedestrian

deductively and require numerous examples to identify a specific object."

Furthermore, it is important to observe corner cases; these are special cases in which pedestrians are not recognised, because of a pedestrian's unusual posture, an obtrusion blocking a sensor's view, or poor lighting due to weather conditions.

Datasets typically lack suitable image material to classify these exceptional cases, but thanks to the GAN structure that has been established, the dataset was supplemented with computer-generated images to mitigate the problem.

Classification

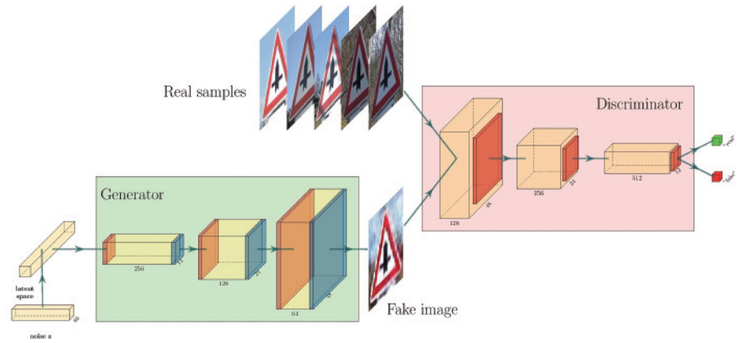
Comprehensive tests helped gain a deeper understanding of the processes that underlie CNN training, focusing particularly on the filtering of object attributes as well as the depiction of regions of interest (RoI) in the image area being examined.

The emergence of these kernel weights and the resulting RoI are essential for finding evaluation metrics and thus automated object classification. In their analyses, experts looked at a number of processes that occur in neural networks and examined approaches to understand the neurons' flow of information.

"Some neurons are more associated with the identification of pedestrians and produce stronger responses than others," said Diviš. "That's why we've tested a range of scenarios in which we deactivated certain neurons to see how they influence decision-making processes. We could confirm that not every neuron responsible for identifying pedestrians needs to be activated, and in fact not removing some neurons can even lead to quicker and better results."

The framework that was created can be used to analyse these types of changes.

All of this allows the stability of algorithms to be sustainably increased, which will serve to make autonomous driving safer. Precautions could be taken, for example, to reduce the risk of an adversary attack, which is the external deployment of a malicious code disguised as a neutral image to compromise the neural network. This code generates a disturbance and influences the decisions of certain neurons, making it impossible to recognise objects correctly.



To train the neural networks, the GAN's generator used an existing external dataset with photos of pedestrians to create computer-generated images. The discriminator distinguished between genuine and generated images. This interaction will improve the generator's ability to make realistic images over time.



Václav Diviš: "It will only be possible to develop optimal safety features for autonomous driving once we have understood neural networks down to the last detail."

The effects of these types of external disruptions could be reduced by removing inactive neurons, as this would provide fewer targets to attack in the neural network.

"We will never be able to guarantee correct object classification 100 per cent of the time," said Diviš. "In the automotive industry, our job is to identify and better understand vulnerabilities in neural networks. Only by doing so can we take efficient counteractive measures and ensure maximum safety."

A system's object classification capabilities can also be improved immensely through the evaluation and combination of various data collected by sensors such as cameras, lidar and radar.



DRIVING BLIND

Bob Leigh explains how DDS can help designers plan for the unknown

Typically, autonomous industrial applications are designed to operate in relatively predictable, controlled environments. In contrast, the automotive industry may have the toughest of all autonomy design challenges: the uncontrollable, unpredictable chaos of public roads.

The design of autonomous personal vehicles – generally between autonomy levels three and five, as shown in Fig. 1, have three major design challenges. Each challenge on its own is largely uncharted territory for OEMs.

These design challenges are:

1. Enabling sensor fusion from numerous sources that generate massive unstructured data flows;
2. Creating increasingly complex systems faster and at a lower development cost; and
3. Ensuring scalability and future proofing

Can bus

The traditional architecture of passenger vehicles is based on the deployment of electronic control units (ECUs) for various subsystems. The Can bus provides the interconnection with ECUs wherever a communications loop

is required.

Today's average vehicle has 100 to 200 ECUs packed into different corners of the car. For the next generation of cars, that number has to come down dramatically. That means finding ways to start consolidating some of that processing power.

To achieve level-two autonomy, OEMs are pushing the boundaries of the Can bus. However, adding ECUs adds to the weight and cost of the car, reducing fuel efficiency. And because there's no way to share applications across ECUs, some features and functions must be duplicated.

To eliminate or consolidate ECUs, OEMs are looking at a number of options. One is incorporating a domain controller in the car, a step towards creating a centralised processing system. This is where the sensor fusion and autonomous vehicle functions will operate, adding functionality that didn't exist before.

Real-time connections to the cloud will become standard. It will be necessary to support high-definition location information that can locate the automobile within a centimetre of its position. High definition maps updated in real time, lidar sensor data accurate to the centimetre, and V2X data coming from other cars, people (mobile phones) and road-side infrastructure, are good examples of the dynamic and bandwidth intensive data a new system must handle.

OEMs are trying to plan architectures for the next five to ten years that take all this and more into account. This requires flexibility for where applications get deployed. The Can bus is hardware dependent and only works with wired components in the vehicle, limiting its ability to provide the foundation for much of the capabilities required for autonomy. In other words, the Can bus is maxed out when it comes to autonomous vehicles.

New Ethernet-based communication protocols, such as Some IP, add more capabilities but are more suitable for large data distribution and highly

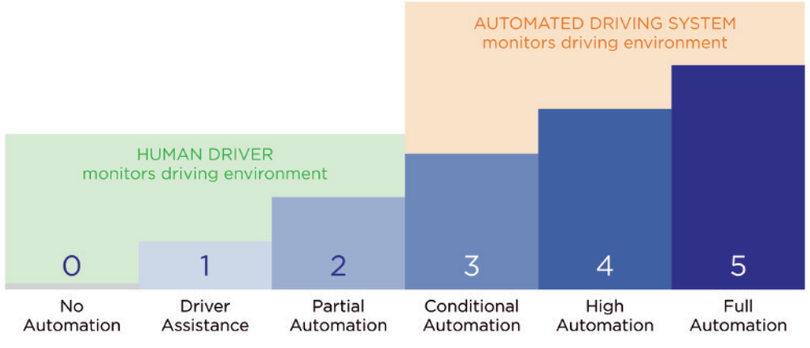


Fig. 1: Accelerating progress towards levels three to five autonomy, while meeting critical requirements, such as safety, security and latency, requires a standards-based data-centric framework

dynamic systems. To future-proof their architectures, designers prefer to avoid building a code base that's designed for a specific ECU. Instead, code generation should be able to run on the ECU, domain controller, central processing system or via the cloud. There are very few technologies that can support this level of flexibility.

DDS databus

To address all of these considerations requires a standards-based framework

AUTONOMOUS VEHICLES

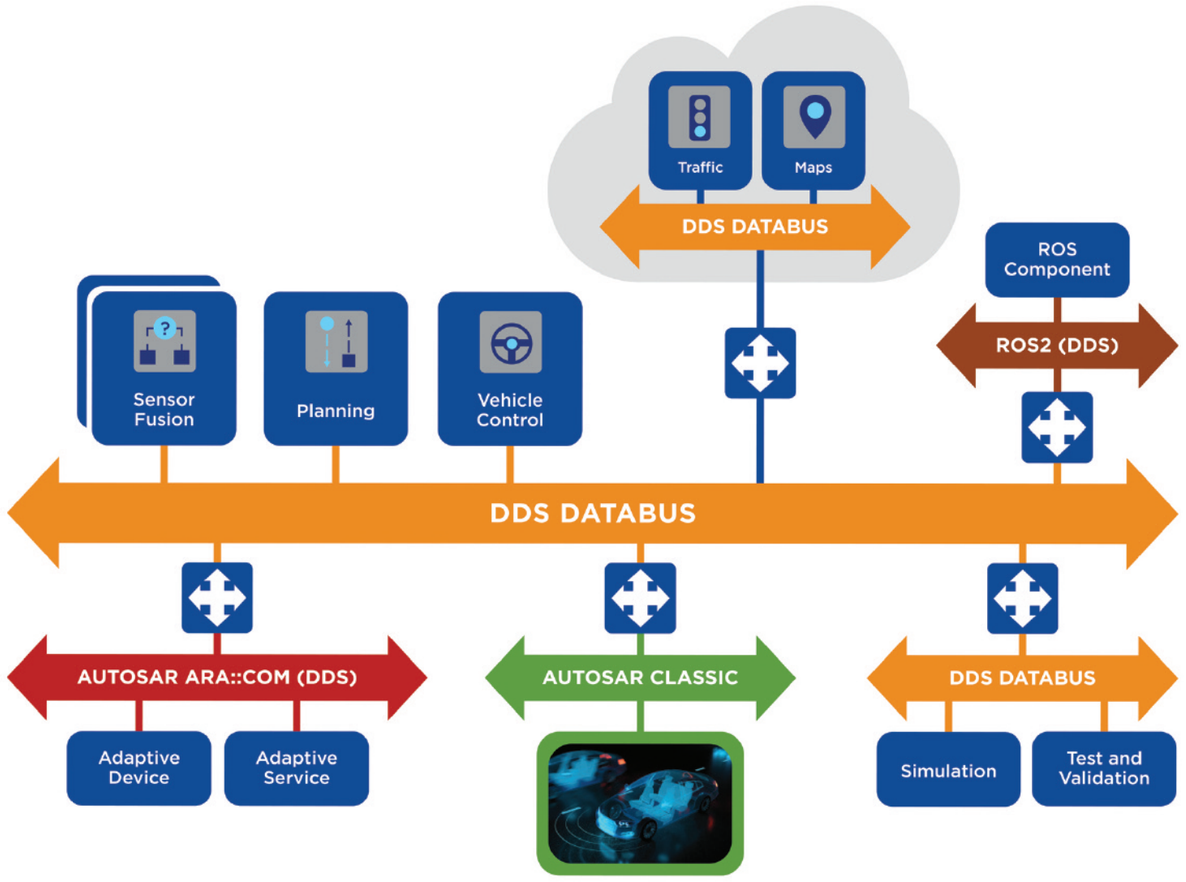


Fig. 2: The DDS databus connects primary autonomy functions, such as sensor fusion and path planning; the databus shares a common data model across other systems and standards including Autosar Adaptive and ROS2

designed for complex industrial systems. The Data Distribution Service (DDS) standard developed by the Object Management Group (OMG) defines an open integration data-centric framework for software applications.

DDS is transport-agnostic, QoS-aware and can handle any volume of data from virtually any number of sources.

As shown in Fig. 2, the DDS databus enables interoperability between applications running on different implementations and interoperability between sources written for different vendors

A data-centric connectivity architecture is based on a software databus. The databus is designed for exceptionally complex systems, precisely as is found in autonomous vehicles. The databus operates as a shared application space where all the data live. It is also what allows applications and devices to work together as one integrated system.

The databus distributes data in motion, unlike the database that manages data at rest. The data serve as the interface between devices but aren't necessarily stored anywhere. Messages do not need to be sent through brokers to access or process those data. This is one of the key attributes that enables real-time response or ultra low latency with a high volume of data from multiple sources.

Sensor fusion

Data volume increases with every level of autonomy. These massive data flows are generated by numerous sources both internal

Source	Volume (approximate)
8 cameras	2.5-20 Gbit/s
4 Lidar sensors	30-300 Mbit/s
5 Radar sensors	~10 kB/s
16 Ultrasonic sensors	~10 kB/s
1 GPS	~10 kB/s
Control commands	~10 kB/s
Status/error handling	Whatever is needed

Table 1: Autonomous systems require sensor fusion for massive amounts of data

and external to the vehicle, as illustrated in Table 1. Handling a greater volume of data means adding more processing power and memory, thus affecting cost.

The DDS databus simplifies handling this unstructured environment. It is designed to handle massive and diverse data flows. Without a data-centric framework, designers need two or three different protocols to handle all this variability.

For example, they would require a protocol for streaming and a different protocol for control functions.

DDS is a single standard and application programming interface (API) that can handle all of these data types. All data are available everywhere and appear to an application as local memory. Architects can designate rules on how data are shared and managed on the databus, including requirements such as how latency and bandwidth are handled.

The connection between readers and writers (a contract between publishers and subscribers) determines what to transmit, to what destination and with what priority, and how to handle collisions or failures on the network.

Speed and cost

Most OEMs don't want to be in the middleware business, especially in the era of autonomy. In-house software development requires expensive internal resources. The DDS databus is not just a framework for sharing large volumes of data, it also provides the ability to identify, prioritise and assign values to specific data streams. It does this in an extremely efficient manner, reducing both complexity and cost.

One example is security, a critical requirement for autonomous vehicles. The autonomous vehicle requires many connections to the outside world. All these connections are vulnerable to interference and tampering. However, it is simply too expensive to secure every piece of software and every data flow.

A DDS databus provides the ability to apply tailored security policies that are specific to each application in the vehicle. There are many dimensions to security. The DDS databus enables designers to apply security selectively, rather than integrating one-size-fits-all sweeping security policies.

DDS Security is a standards-based security architecture that can be optionally applied without impacting application development. Security is applied after the API calls, but before it is published on the network. This makes it independent of the application code, and independent of the network transport protocol.

In the DDS standard, each data piece is called a topic. Each topic can be individually tuned. Not every data flow needs to be secured at the same level of strength. With topic-level security, the security architects can specify

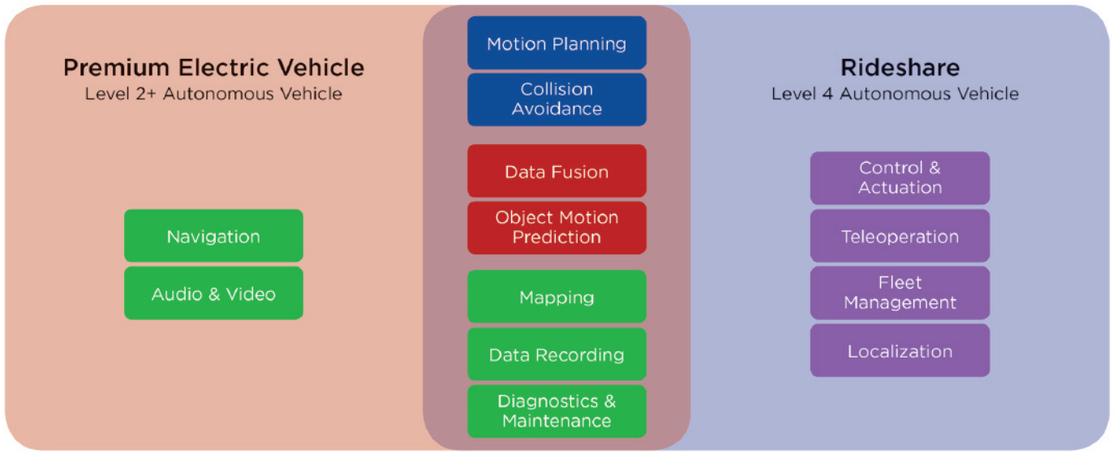


Fig. 3: Different use cases will have different hardware and software designs; while the electric vehicle seems to be entirely different use case for autonomy, the optimum design will reuse a lot of IP

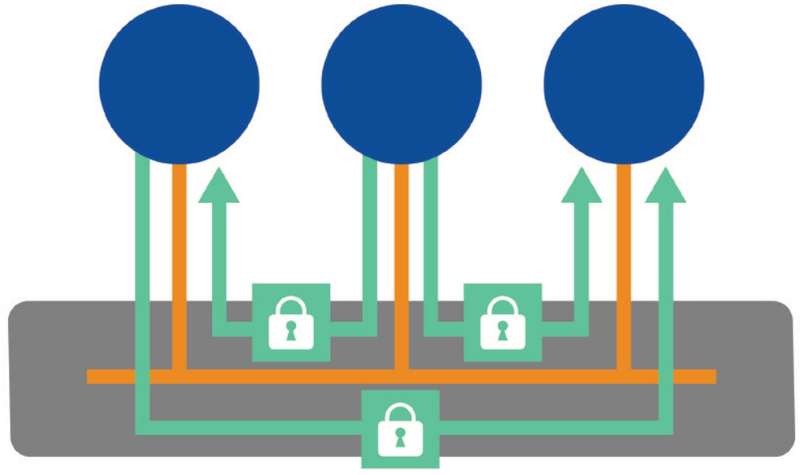


Fig. 4: DDS enables dataflow security

what level of authentication each data topic requires. What are the access control roots for these data? What's the encryption required for these data? The ability to assign security on a per-topic basis offers significant advantages for reducing cost and complexity while strengthening security.

Scalability

For autonomous vehicles, scalability is a multi-faceted requirement, encompassing:

- The flexibility to run new software on the ECUs, domain controller or in the cloud.
- The ability to support different devices, different systems and different networks. This requires the ability to plug in new sources easily and apply different policies, such as QoS and security, to the new data by topic.
- The ability to extract data across multiple, fast-moving internal and external sources.
- The ability to incorporate off-the-shelf or common components to reduce the cost of developing and maintaining custom software and hardware.
- The flexibility to swap components and upgrade the CPU or install a more powerful sensor without changing the core functionality of the component.

The DDS databus scales both horizontally and vertically. Designers don't have to pre-configure the system to try to anticipate how data might be shared someday. DDS builds that aspect of scalability into the architecture itself.

Another aspect to scalability is the need to meet the design requirements of additional car models with varying requirements for autonomous features. Developing applications for single use instances is very expensive. OEMs need the ability to design applications and functions for luxury class vehicles and adapt the same applications for economy vehicles.

Beyond that, designers want to reuse IP in developing autonomous vehicles for other use cases. As shown in Fig. 3, the DDS databus can support the requirements for an electric vehicle operating at level-two autonomy as well as a level-four autonomy rideshare vehicle.

Ideally, OEMs want platforms that can scale as seamlessly as possible from levels two and three up to level five, but can also accommodate the requirement to move in increments or leaps to higher levels of autonomy.

Finally, OEMs need to plan for future scalability across teams and applications. Start with a car that can drive itself within a certain city. Then add more capabilities so that car can drive anywhere in the country or anywhere in the world.

This implies not only more software applications but also more people and teams working on that software. It means data sharing regardless of what the transport is, whether the data are coming from backend servers or embedded systems.

Predicting what architectures will be dominant in the next five to ten years is nearly impossible. Designing for a future of so many unknowns is really the overarching requirement that makes the DDS databus so valuable.

Bob Leigh is senior director of market development for autonomous vehicles at Real-Time Innovations (RTI)



INFOTAINMENT

Modern connectivity for timeless classic cars

Porsche has introduced modern infotainment systems that can be retrofitted into classic cars

Porsche wants to opens up the digital world to the brand's vintage and young classic cars. As such, it has developed Porsche Classic Communication Management (PCCM) in two variants that can exactly replace the original built-in units with 1-Din or 2-Din dimensions.

Both infotainment systems offer a high-resolution touchscreen and modern functions such as Dab+ and Apple CarPlay as well on-board navigation.

The PCCM is a further development of the previous radio navigation system for classic Porsche sports cars. Like this system, it fits exactly in the 1-Din slot that was standard in sports cars for many decades.

The PCCM is operated via two rotary knobs, six integrated buttons and a touch-sensitive 8.9cm display. Like the predecessor model, it includes a navigation function with point-of-interest search in an enhanced version.

Route guidance optionally takes place as a simple arrow representation in a 2D or 3D view. The corresponding map material is provided on a separate SD card.

The PCCM can now also receive digital radio stations with Dab+. A further highlight for this device class is integration of Apple CarPlay.

For the first time, all users of an Apple iPhone from version five can now also use their iPhone apps for media playback, navigation and telephony while driving. Media playback is also possible via an SD card, USB, aux and Bluetooth.

The PCCM blends harmoniously into the dashboard of Porsche classic cars thanks to the black surface finish and the shape of the knobs. It features the Porsche logo and is suitable for the sports car generations between the first 911 models of the 1960s and the last 911 with air cooling from the start of the 1990s (993 model series). Use in earlier front- and mid-engine models is also possible.

The 911 models of the 996 generation and Boxster models of the 986 generation, which were built in the 1990s, could already be optionally equipped with a Porsche Communication Management (PCM) system in 2-Din format. For these sports cars, Porsche Classic has developed the PCCM Plus, which features a high-resolution 17.8cm touchscreen with optimised display.



PCCM in Porsche 911F

The haptic and visual design of the PCCM Plus is based on the adjacent components such as air vents or pushbutton switches. The PCCM Plus can thus be integrated seamlessly into the ambience of the classic sports cars. The peripheral components already installed in the vehicle such as amplifier, loudspeakers or antenna can still be used. The navigation displays in the instrument cluster are also still supported.

Operation via the touchscreen and buttons takes place largely in accordance with the intuitive high standard usual in Porsche vehicles today. This means the latest on-board navigation system with Porsche-specific points-of-interest is also available to the driver.

Route guidance takes place in a 2D or 3D view. Map data and later updates can be used via a separate SD card. Media playback is possible via SD card, USB stick, aux and Bluetooth.

Like the PCCM, the PCCM Plus also offers an interface to Apple CarPlay. In addition, the 2-Din unit is also compatible with Google Android Auto.

Porsche Classic is responsible for spare parts supply and factory restorations of all of the brand's road-approved classic cars. This includes all aspects of care products and technical literature through to classic spare part supply and new editions of already discontinued spare parts.

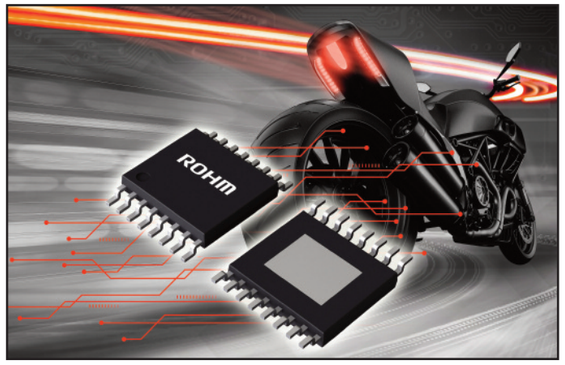
To increase the availability of this offering for vintage and young classic cars, the company is successively extending its international dealer and service network with the Porsche Classic Partner programme. Porsche customers and prospects can find the complete range of products and services offered by Porsche Classic there.

In this way, Porsche is integrating maintenance and value retention of classic cars into an innovative service concept that closely links the tradition and innovation of Porsche.



PCCM Plus in Porsche 996

LED drivers cut board area on motorbikes



A four-channel linear LED driver IC from Rohm has a built-in mosfet and is suitable for LED rear lamps (turn and stop), fog lamps and turn signals on motorcycles.

The BD183x7EFV-M units incorporate a proprietary thermal dissipation circuit and individual LED control function.

To reduce board area, output channels are consolidated into one terminal, allowing a configuration a four-channel high output driver into a 16-pin package.

To reduce design effort, the heat distribution circuit allows simplification of the overall thermal design. The LED control function enables individual or collective control of LEDs in case of errors, to comply with motorcycle standards for licence plate lighting.

The heat distribution circuit consolidates the heat dissipation terminals into one to achieve 150mA/ch output in a 16-pin form factor while increasing the maximum number of channels to four.

In conventional vehicle rear-lamp systems, two LED drivers are needed to power four LED strings. This IC makes it possible to drive all four strings with one driver.

The individual LED control function can simultaneously drive two different types of LEDs, reducing board area by halving the number of ICs.

The thermal distribution circuit consolidates the multiple heat dissipation circuit terminals into one, reducing design effort by allowing thermal design typically required for each channel to be completed in a single design step.

The built-in control function allows the selection of either collective or individual LED off, in case a rear lamp fails to light up. Designers can select to turn all LEDs off or only the failed string, enabling compliance with multi-regional laws with one setting, reducing the number of redesign hours.

It provides an individual dimming function for sequential lighting by adding external resistors.

Other features include open and short detection for vehicle lamps, abnormality detection for each channel and protection functions to prevent damage to the circuit, LED driver and peripherals.

Software ensures safe data comms

OEMs and embedded software developers can use software from Blackberry to ensure safe data communication exchanges within their safety-critical systems.

The QNX Black Channel communications technology is certified to ISO 26262 Asil D and is based on the safe data communication requirements in IEC 61508 and mitigation measures defined in Autosar end-to-end communications protection profiles.

The software makes the countless nodes of data communications in embedded systems functionally safe.

By safely encapsulating the data being exchanged and validating them with essential safety checks, it protects data communication from systematic software faults, random hardware faults and transient faults while helping in the automatic prevention of damages from these failures, all with little impact on system performance.

The technology provides a safety layer to protect data being passed from point to point while being agnostic of the underlying communication software and hardware. With the functional safety standard development and certification already done, it lets car makers and other embedded software developers accelerate their development timelines and reduce the cost in moving projects from research to production.

Select OEMs and tier-ones are using the software in their development and it is now generally available.

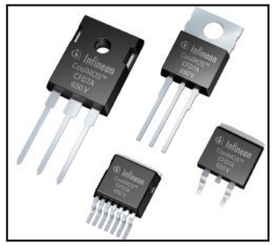
EV charger mosfets suit PFC and DC-DC stages

Supporting the needs of the electro-mobility market, Infineon has launched the Coolmos CFD7A series of silicon-based products that can be used in the PFC and the DC-DC stage of on-board charger systems and HV-LV DC-DC converters for electric-vehicle applications.

The devices are compatible with system voltages up to 475V DC. Higher efficiency levels are made possible by the Kelvin-source concept reaching peak efficiency levels up to 98.4 per cent measured.

Thanks to an intrinsic fast body diode and the range of TO and SMD packages, the devices are suitable for PFC and DC-DC stages.

The family allows the reaching of higher switching frequencies with low gate losses enabling more power-dense and hence more compact designs. Additionally, the platform was tailored to meet the needs of the rough automotive environment, especially in terms of cosmic radiation and design robustness.



Cosmic radiation was tackled from the beginning of the development process and is proven by experimental results.

When using the 650V technology with the D²Pak seven-pin package, designers can benefit not only from the enhanced efficiency but the thermal behaviour and extended creepage distances.

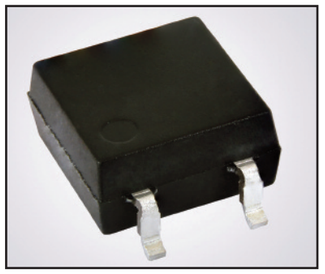
The family is manufactured on an automated 300mm production line.

Devices come in TO-220, TO-247, TO-247 short leads, D²PakK three-pin and D²Pak seven-pin packages.

Phototransistor optocoupler

An automotive-grade phototransistor optocoupler from Vishay Intertechnology combines a high current transfer ratio (CTR) from 50 to 600% with a forward current of 1mA in the sop-4 mini-flat package.

With 80% lower forward current than the previous generation, the VOMA618A is designed to save energy in automotive and high reliability applications, while its package saves board space.



The AEC-Q101 qualified device is for galvanic and noise isolation, signal transmission, battery management, 48V boardnets, and system control in hybrid and electric vehicles.

It has a GaAlAs infrared emitting diode that is optically coupled to a silicon phototransistor.

The mini-flat package provides 3750V isolation voltage rating and creepage and clearance distance of 5mm and above.

Coupling capacitance is 1.2pF, and the device is RoHS-compliant, halogen-free and Vishay Green.

LED for fog lamps

The Synios P2720 CR LED from Osram is for manufacturers of rear combination lamps, such as enabling compact rear fog lamp designs.

One of the main issues with monochromatic LEDs for rear fog applications is the loss of brightness, often called degradation, of about 50 per cent at operating temperatures of +60 to +70˚C. Until now, rear lamp manufacturers had to compensate for this physically induced gap by increasing the number of LEDs, which also increased the space requirements.

This conversion-based LED can reduce this loss of brightness to only around ten per cent, so fewer individual LEDs are required.

This means the required heat sink can be compact, saving additional space and weight.

Rear lamp manufacturers can choose between two chip sizes – 0.5mm² (49 lm, 350mA) or 1mm² (103 lm, 700mA) – depending on the design of the application.

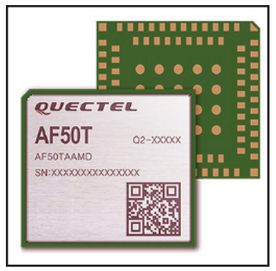
The package dimensions of 2.0 by 2.7 by 0.6mm remain the same.



Module brings Wifi 6 to IoV

Quectel Wireless has announced the automotive-grade AF50T module based on the Qualcomm QCA6696 Wifi 6 chip.

The module is designed to deliver enhanced performance in capacity, data rates, latency, power consumption and coverage, bringing premium wireless performance to automotive applications, such as the internet of vehicles (IoV).



The module supports IEEE 802.11 ax and BT 5.1, and is backwards compatible with 802.11 a/b/g/n/ac protocols.

In addition, the low-power Wifi 6 module supports dual mac, 2.4 and 5GHz dual bands simultaneous (DBS) in 2x2+2x2 mode, mu-mino with 8x8 sounding, OFDMA and 1024-QAM capabilities, which can deliver faster, more secure and robust wifi performance, with a maximum data rate of 1774.5Mbit/s.

The device adheres to the IATF 16949: 2016 standards and complies with automotive quality processes including APQP and PPAP, which ensures they meet the requirements of the automotive segment.

It is designed for IoV applications, such as in-vehicle infotainment and on-board diagnosis. The module measures 19.5 by 21.5 by 2.3mm in LGA form factor.

When combined with Quectel's AG520R LTE-A plus C-V2X module and AG550Q 5G plus C-V2X module, it makes an LTE-A/5G plus Wifi/BT combination to address in-vehicle information processing demands, such as hot spot, data uploading and car monitoring.

Benefiting from its software and hardware functionality, it can cope with channel interferences, and is designed to work with the two C-V2X modules.

Operating temperature is -40 to +85˚C. Designed with a PCIe 2.0 interface to provide WLAN capability, it can achieve low-power and high-speed data transmission.

Clock buffers deliver low jitter

Automotive-compliant clock buffers from Diodes are for low-power operation in ambient temperatures up to +105˚C, as found in adas, infotainment and automotive gateways.

Increasing sophistication of automotive electronics has led to more complex system clock trees. The increased number of clock signals has created a demand for clock buffers that can deliver low jitter and low skew, while reducing system power.

Implemented using a low-power cmos process, the clock buffer family operates from an input between 1.5 and 3.3V. All clock inputs are aligned and synchronised, which maintains low skew, and the cmos design introduces little phase noise, resulting in low additive jitter.

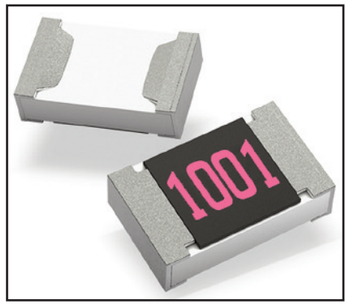
The family includes the Hyperlink PI6C49CB-01Q (one differential input, one single-ended output), 02Q (one single-ended input, two single-ended outputs) and 04xQ (one single-ended input, four single-ended outputs).

All inputs and outputs are compatible with LV-cmos and LV TTL signal levels.

The parts are qualified to AEC-Q100 with PPAP support and are manufactured in IATF16949 certified facilities.

They come in eight-pin soic packages.





Chip resistor fights against sulphurisation

The latest member of Panasonic's ERJU resistor series broadens its portfolio of anti-sulphurated thick-film chip resistors with a lower temperature coefficient of resistance than the existing product line.

The ERJU-RD has an Ag-Pd-based inner electrode to improve resistance against sulphurisation. This was tested in an +85˚C oil bath.

The device has a TCR of ±50 ×10^{-6}/˚C. This makes it attractive for applications that are meant to operate under physical strains such as heat, oil or vibrations.

Resistance tolerance is ±0.5%. It complies with AEC-Q200 and RoHS.

The firm's thick-film chip resistors come in cases sizes from 01005 to 2512. The SMD resistors use a soft termination structure for better solder-joint reliability to reduce cracks in the solder fillet, caused by tough temperature cycle conditions.

Development tool for smart gateways

The SGP smart gateway platform from ST Microelectronics provides a development tool for prototyping automotive smart-gateway and domain-controller applications.

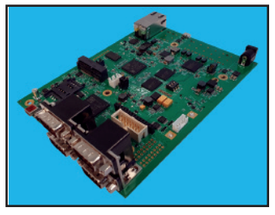
The evolution of automotive architectures to include high throughput in-vehicle networking and high data-rate connectivity to the cloud has increased demand for high-performance smart-gateway and domain-controller ECUs.

The modular platform, built on Gigabit Ethernet communications between the secure and Asil-B Telemaco 3P MPU and the Asil-D SPC58 Chorus MCU, can handle firewall functionalities, predictive maintenance, over-the-air (OTA) upgrades, and high data-rate communication among different ECUs and to the cloud.

While the Chorus MCU provides real-time, low-power, and secure in-vehicle connectivity through its multiple Can-FD interfaces, the Telemaco 3P MPU extends gateway computational capabilities by delivering dual Arm Cortex A7 processing power with the Posix Os support and embedded security module to handle OTA updates, firewall and predictive-maintenance functions.

The reference design has a set of in-vehicle network interfaces including multiple Ethernet and Can ports as well as support for Lin and Flexray connections. It is deployed with a starter package including hardware design files, hardware and software documentation, software utilities (drivers and flashers), and sample applications.

It also integrates expansion connections to wifi and LTE modules for prototyping of use cases requiring cloud-connectivity simulation. The modular architecture provides a framework for platform scalability in performance, networking and software.



Chokes suppress radio interference

Würth Elektronik has complemented its AEC-Q200 group of qualified radio interference suppression chokes with an SMT-mountable model.



The WE-RCIS rod core choke, available in four versions, is characterised by its high current-carrying capacity and saturation power.

It is suitable for integrated DC-DC converters, for low-consumption use and energy harvesting, embedded systems, portable devices, and automotive electronics applications.

The inductance is qualified to AEC-Q200 grade one and thus has an operating temperature of -40 to +150˚C.

The design and the contacts, which provide for a large area solder connection, make the coil suitable for shockproof circuits.

DC-DC converter suits hybrid EVs

A 3kW bi-directional non-isolated DC-DC converter from Calex is for use in hybrid electric vehicles.

The 48S12.3K0 BCA weighs 1.3kg and measures 22 by 15.6 by 2.56cm. The rugged design has a 97% efficiency.

The packaging and thermal design make the converter suitable for harsh shock and vibration requirements, as well as easy integration with a battery pack.

Standard hybrid electric vehicle architecture typically requires the use of two independent batteries at different voltages, and the converter was created in response to these requirements.

It charges a low side (12V) battery during normal operation (buck mode) and charges or assists the high voltage (48V) battery in emergency situations (boost mode). In the event that the 48V battery requires charging while in boost mode, the unit enters into pre-charge mode.

Features include a disconnect switch based on a back to-back mosfet configuration for the low side (12V battery), reverse voltage protection, short circuit protection, and low standby current for the low side. The baseplate of the enclosure allows for ease of mounting to a chill plate or chassis.

The operational baseplate temperature range is -40 to +100˚C.

A Can 2.0B interface is used for complete control of the converter, as well as monitoring the low-side current and the internal temperature.

Additionally, it uses a high-speed Can transceiver for communication with the microcontroller.





IoT edge gateway for connected cars

An automotive-certified multi-service IoT edge gateway from Eurotech carries features for intelligent mobility and connected vehicles.

The Dynagate 20-30 combines hardware, software and connectivity and is based on the Intel Atom x5 and x7 E3900 processors.

The fanless unit has an extended operating temperature range, IP54 ingress protection, wide range automotive power supply and a native support for automotive and industrial protocols.

Connectivity capabilities include a global LTE Cat 4 cellular modem, wifi, Bluetooth Low Energy and GPS with untethered dead reckoning.

Real-time kinematic (RTK) positioning is also available as a factory option to enhance the precision of position data for applications where this is important, such as precision agriculture.

Integrated hardware and software security comes through a dedicated TPM 2.0 chip and it is secure boot ready.

Powered by the Everyware ESF software framework, the gateway is said to be easy to use, programme and manage. The web-based user interface lets users visually compose data flows, such as the ones to acquire data from the vehicle through the built-in support for SAE J1939 and J1708.

Vehicle data can then be analysed at the edge and published to the cloud though the MQTT protocol. The Everyware Cloud IoT integration platform provides data integration to the applications and offers management of devices deployed in the field.

There are customisation options for hardware, such as additional features, custom front panel and connectors, and branding, and software such as customised application images.

Cable-to-board connector mates reliably

Erni is expanding its MiniBridge 1.27mm pitch and MaxiBridge 2.54mm cable-to-board connector families with the single-row MicroBridge family in a 1.27mm pitch targeting the automotive sector.

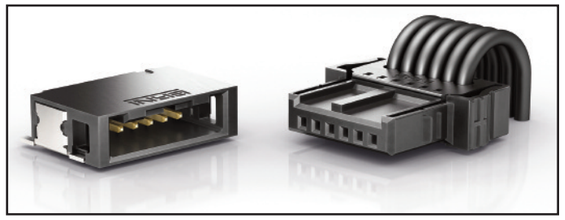
The cable-to-board connector has been developed in accordance with the VW75174 and USCar-2 automotive test specifications.

Koshiri security, an optional electrical connector position assurance (e-CPA), and possible colour and mechanical coding for any number of pins ensure safe and reliable connections. Koshiri security means protection against damage caused by improper or skewed insertion.

Tongues on the female connector and grooves on the male connector allow the pre-alignment of the connector housings, ensuring a precise mating process. The contact pins of the male connector are not damaged by improper, skewed mating.

The e-CPA enables testing for secure contact between the female and male connectors even during the mating process. A shortened test pin without signal and power supply function is used on the male connector for this purpose.

This connector can withstand harsh environments with vibrations or shock loads as specified in VW75174 and high temperatures in the vehicle. This is helped by the latching mechanism on both sides and the high-temperature resistance.



The housing latching mechanism on both sides provides acoustic and haptic feedback of the interlocking during the mating process. The latching mechanism can be released without tools.

The solder clips of the male connectors absorb mechanical stress and resist high shock and vibration loads. High-temperature resistance is up to +150˚C.

It comes as a single-row male connector in straight and angled SMT versions. The male connectors come in tape-on-reel packaging for automatic assembly. The single-row female connectors are available as IDC insulation displacement versions. They are available with a 90˚ cable outlet.

The double design of the insulation displacement terminal improves reliability. In addition, the integrated strain relief protects the IDC from mechanical stress caused by cable movements.

The cable connector with a 1.27mm pitch is available in a single-row version. Pin counts from two to 20 are possible. The current rating per contact is 9.0A at +20˚C for the two-pin version.

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Published by: Vehicle Electronics Magazine,
72 Westwood Road, Nottingham NG2 4FS, UK

Web site: vehicle-electronics.biz
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ISSN 2055-1177

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