VEHICLE electronics

The monthly magazine for automotive electronics engineers

Mobileye self-driving cars hit streets of New York

Mobileye is testing autonomous driving around the streets of New York.

The Intel subsidiary wants to demonstrate its autonomous vehicle technology in the largest city in North America and one of the world's most challenging driving environments.

"Driving in complex urban areas such as New York is a crucial step in vetting the capabilities of an autonomous system and moving the industry closer to commercial readiness," said Amnon Shashua, CEO of Mobileye.

The camera-only subsystem is driving through New York on highly congested streets with pedestrians, bicyclists, aggressive drivers, double-parked vehicles, construction zones, emergency vehicles, tunnels and bridges.

The approach first uses the computer-vision subsystem before adding a lidar and radar subsystem for redundancy.

Mobileye applied for and received an AV testing permit to drive the vehicles on New York streets for both day and night driving.

It will have to deal with pedestrians in a city where jaywalking is common. The AV must make assumptions about the behaviour of those pedestrians and factor those assumptions into its driving policy.

The technology must also deal with New York's aggressive cabbies and other professionals.

Although car ownership in New York is low compared with other large US cities, the number and variety of road users is especially dense.

The population density also contributes to a high number of delivery vehicles that must stop to unload. As a result, double-parking is ubiquitous. AVs struggle with this, but Mobileye's AVs takes clues from other road users to decide when to manoeuvre around.

Mobileye already receives data about blocked or closed lanes from cars on the road.



Mobileye AV on the streets of New York

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LDRA and OpenSynergy form defence strategy

To alleviate security concerns in automotive, LDRA and OpenSynergy are working together to support and promote a defence-in-depth strategy combining hypervisor technology with secure coding techniques.

LDRA provides automated software verification, source code analysis and test tools, and OpenSynergy is a specialist in embedded automotive software.

Vulnerability to attacks from bad actors has been demonstrated in vehicles from a range of manufacturers. The rise in popularity of electric vehicles adds to that unease because several features of connected EVs such as the batteries and their charging systems have safety implications.

The benefits of virtualisation in automotive are known, and Coqos hypervisors are an opportunity for developers to reduce cost, device seize, weight and power while improving CPU performance and providing a migration path for unmodified legacy applications.

It is their capacity to provide a mechanism for domain separation, however, that is critical to automotive cyber security.

The need for inter-process communication (IPC) between those domains is inevitable and a source of vulnerabilities. The role of secure application code is pivotal in that context because the code handling the data processed by IPCs has a role to play in defending a potential weakness in a virtualised architecture.

OpenSynergy focusses on the automotive virtual platform Coqos hypervisor SDK based on Virtio technology. The hypervisor on this platform runs directly on the SoC application cores and creates several virtual machines (VMs). Each VM is isolated from the others.

This separation makes it possible to run functions with different real-time behaviour and functional safety requirements on a single SoC.

"The wisdom of a defence-in-depth strategy is unquestionable," said Matthias Stumpf, VP at OpenSynergy.

Both the LDRA tool suite and the OpenSynergy hypervisors have been certified by SGS TÜV as suitable for development of safety-related software compliant with ISO 26262. The LDRA suite has tool qualification support packs.

Sam's the man at Goodwood



Paralysed race car driver Sam Schmidt drove up the Goodwood Festival of Speed's iconic 1.86km hill climb course with the Arrow Electronics semi-autonomous mobility car in July wearing a specially designed exoskeleton suit.

Schmidt owns Indycar team Arrow McLaren SP and is a former Indy Racing League driver, who crashed in 2000, severely injuring his spine and becoming a quadriplegic.

To help Schmidt drive again, Arrow engineers created a smart, connected vehicle that he can operate safely and independently using head controls and voice commands.

The car is a modified 2020 Corvette that Schmidt has driven in amateur races, broken speed records and cruised down public streets in several US cities. Arrow designed the Sam Suit with robotic engineering researchers at Vanderbilt University. It supports Schmidt's torso and arms, as well as his lower extremities.

NXP gateway helps Moter provide risk-based cover

NXP Semiconductors has been working with insurance tech company Moter on a service-oriented gateway that could be in vehicles by the end of the year and will allow driver monitoring functions to be processed in the car rather than streaming vast amounts of data to the cloud.

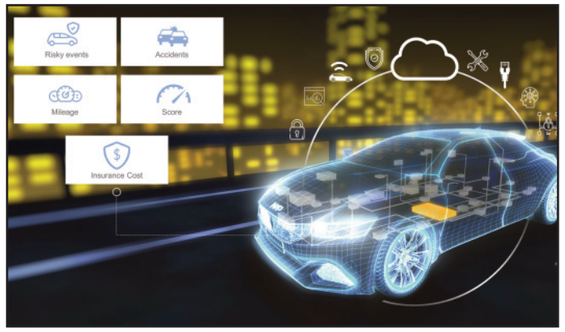
The hope is this will lead to new levels of risk-based insurance.

NXP's GoldBox reference design, based on one of the recently launched S32G2 vehicle network processors, is an enabler for vehicle data-driven opportunities such as insurance, vehicle health and fleet management services.

It provides secure vehicle edge processing, support for over-the-air services, and connectivity to in-vehicle networks and the cloud required for modern automotive applications.

The processors provide both real-time and applications processing combined with vehicle network interfaces, network acceleration and hardware security, along with expansion support for machine-learning acceleration, mass storage and wireless connectivity to deliver a service-oriented gateway.

Brian Carlson, global marketing director at NXP, said these gateways could be in vehicles by the end of this year or early next year and provide the platform that insurance companies could use for more accurate risk-based insurance.



NXP and Moter enable risk-based insurance

"Vehicle data will power new automotive business opportunities in the near future, similar to the apps proliferation and big data insights provided by the smartphone over the past decade," said Carlson.

Michael Fischer, chief digital officer of Moter, described the insurance industry as being very data hungry.

"Usage-based insurance is one of the data commercialisation opportunities with the most customer satisfaction and revenue potential for the automotive industry today," said Fischer. "Together with NXP, Moter is providing the data bridge that will enable the automotive industry to unlock the riches of data for mobility insurance, fleet health and monitoring and infrastructure planning and optimisation."

The platform contains risk algorithms that can be updated over-the-air and combined with an insurance carrier's or mobility company's custom insurance algorithms to create marketable driver insights. It can be licensed for use with OEM vehicles to facilitate data exchange with insurers and mobility companies who are willing to subscribe and pay for driver insights to enable data-driven products, such as usage-based insurance.

Faurecia acquires DesignLED

French automotive supplier Faurecia has acquired Scottish LED lighting firm DesignLED Products for an undisclosed sum.

DesignLED has developed flexible technology for automotive lighting and HMI applications.

DesignLED CEO Stuart Bain said: "In recent years we have established the company as a leader in automotive lighting and HMI innovation, building a reputation based not only on an extensive technology and intellectual property portfolio, but also the highly skilled and energetic team, which is already delivering ground-breaking lighting for international OEM and tier-one customers."

He said he hoped to use Faurecia's global reach, international customer base and engineering and manufacturing skills to accelerate adoption of its differentiated display and back-lighting technology.

"DesignLED's advanced technologies and team will enrich Faurecia's display technologies ecosystem," said Edouard da Silva, product line director at Faurecia. "Immersive experiences are fast becoming a defining factor in mobility and, through the acquisition of DesignLED, we aim to strengthen Faurecia's unique positioning in cockpit user experiences."

Littelfuse and Hirtenberger speed over-current detection

Littelfuse and Hirtenberger Automotive Safety have formed a joint venture called Pytic to develop a pyrotechnic-based separator acting as a galvanic cut-off device for e-mobility applications in hybrid and full electric vehicles.

Pytic is anacronym for pyro technology for intelligent circuit disconnection, and brings together the core competencies, development expertise and production know-how of both companies: sensors, fuses and signal processing from Littelfuse; and pyrotechnically driven circuit breakers from Hirtenberger.

Pytic has developed the PSM pyro safety module consisting of individual components aligned with each other for fast detection of over-currents and thus a faster and safer disconnection of the battery from the rest of the vehicle, as quickly as 1ms. This means vehicle fires and electric shocks to passengers and rescue forces can be avoided.

The PSM comes in 500 and 1000V power classes and users can choose different sensor options.

Pytic development teams are working on integrating circuit protection technologies as well as analytical and monitoring features focused on the safety and performance of electrical energy storage systems.

"With the development of the Pytic joint venture, we are excited to see Littelfuse and Hirtenberger working together to bring innovative, value-added technology to customers across the global automotive industry," said Alexander Conrad, Littelfuse senior vice president. "By bringing together our strengths, we are well-positioned to co-develop state-of-the-art products that help empower a sustainable, connected, and safer world."

Markus Haidenbauer, CEO of Orasis Industries, Hirtenberger's parent company, added: "Forming the joint venture represents a strong partnership focused on bringing the best to our collective customers. With the unparalleled expertise of our two companies working together, we can offer the precision, protection, productivity and performance customers demand."

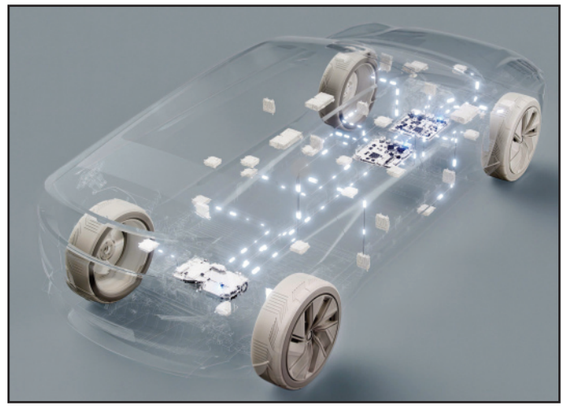


Volvo takes software development in-house

Volvo Cars is taking software development in-house as a car's appeal becomes more defined by software-driven functions.

The next pure electric Volvo models, including the company's first SUV on a completely new electric-only base, will run on Volvo's own operating system, called VolvoCars Os. This will be coupled with more frequent over-the-air updates to cars through their lifetime.

VolvoCars Os will act as an umbrella for electric Volvo cars. It incorporates the company's various operating systems across the car and the cloud, creating one coherent software environment. The underlying operating systems include Android Automotive, QNX, Autosar and Linux.



Volvo is moving towards centralised computing

Through APIs, including the previously announced Extended Vehicle API, the operating system gives developers access to in-car features such as vehicle sensor data, user interfaces and cloud-based features such as fleet data, subject to user consent. This lets developers create more services and applications.

"By developing software in-house, we can boost development speeds and improve your Volvo faster than we can today," said Henrik Green, chief technology officer at Volvo Cars. "Just like on your smartphone or computer, new software and features can be rolled out swiftly through over-the-air updates, making your Volvo better and even more enjoyable over time."

Volvo Cars is also centralising computing inside its fully electric cars into a core system, removing a lot of complexity. Rather than relying on multiple electronic control units around the car that control individual features, an increasing amount of in-house-developed software will run in a core computing system.

The core computer, which will first be introduced on a Volvo model set to be revealed in 2022, is made up of three main computers. These support each other in operating vision processing and artificial intelligence, general computing and infotainment.

The shift to centralised computing also allows Volvo to separate hardware from software. This means the company can introduce more frequent hardware cycles, so that new models can be equipped with the latest available hardware.

Volvo is working with Nvidia on the core systems, and Google is its co-development partner for infotainment.

"We have a deliberate strategy of partnering with true technology leaders where it makes sense," said Green. "Google is a true leader in user experience and services, from Google Maps to Google Assistant, while Nvidia gives us access to some of the fastest and best computing available. This approach of selected strategic partnerships is much more effective than trying to do everything on our own."

Volvo has opened up VolvoCars Os to third-party developers through open APIs.

HMS acquires Owasys

HMS Industrial Networks has acquired 60% of Spanish firm Owasys Advanced Wireless Devices.

With 20 employees, Owasys designs and manufactures wireless products for utility vehicles and industrial machines.

Its wireless embedded communications enables remote monitoring and control of machines.

The portfolio includes an IoT platform for controlling and monitoring data from vehicles.

"Owasys allows HMS to enter the vertical of mobile machines and utility vehicles which is an interesting part of our strategically important information centric playing field," said Staffan Dahlström, HMS CEO.



TomTom adapts adas to meet EU ISA rules

TomTom's Virtual Horizon map-based adas software can help passenger and commercial vehicles anticipate the road ahead and meet European intelligent speed assistance (ISA) requirements.

This software for automakers provides a seamless connection between digital maps and adas functionality, allowing vehicles to see beyond the range of their sensors, for a smoother and safer drive.

ISA systems prompt and encourage drivers to slow down when they exceed the speed limit. The legislation, adopted by the European Commission at the end of May this year, mandates all new passenger and commercial vehicle models sold in the EU to be equipped with an ISA system by July 2022 to pass type approval.

By July 2024, all new passenger and commercial vehicles sold in the EU will be required to be equipped with ISA. Similar ISA legislation is being considered in Iceland, Israel, Norway, Switzerland and the UK.

The regulations say all systems will require accurate explicit and implicit speed limit sign information across the EU.

"To be compliant with ISA requirements, automakers need fresh and accurate map data delivered to the ISA function in an easy-to-integrate manner," said Antoine Saucier, managing director of TomTom Automotive. "TomTom offers automakers a one-stop ISA shop with Virtual Horizon."

It includes precise positioning, intelligent route prediction and a horizon provider that can be compliant with standard protocols. The software is built on TomTom's adas map content used in millions of automated vehicles around the world.



TomTom helps car makers comply with ISA rules

The software supports all of TomTom's adas map's road attributes including speed limits, traffic signs, gradient, curvature, lane information and traffic lights, for the implementation of L0 to L2 adas functions, but it can also be optimised for ISA compliance with speed limits alone.

It can be delivered using automakers' preferred data format and the software leverages existing connectivity where available or works fully offline, reducing onboard hardware costs.

Audi picks Mobileum to test connected cars

Audi is deploying Mobileum's technology to test and monitor the end-to-end quality of its connected cars.

Audi supports more than five million connected cars in 74 countries.

Mobileum's technology allows Audi to test its connected cars remotely from a central location.

The capacity to test remotely has allowed Audi to save money and decrease the pressure on its global supply chain.

This has led to reduced costs with local team support and maintenance when shipping cars overseas.

This proved particularly important during the Covid-19 pandemic, allowing Audi to enhance quality by improving service uptimes and reducing disruptions caused by missing or faulty basic components.

Mobileum's global roaming test platform, GlobalRoamer, is said to have the world's largest testing footprint and enables service providers to automate a wide range of functions, such as remote eSIM provisioning and end-to-end quality testing and monitoring.

In addition, Mobileum will enable Audi to support safety features, such as e-call, with end-to-end active testing that monitors and troubleshoots emergency services and platforms.

"To meet consumer expectations, automotive manufacturers need to partner with leaders in the communications' industry to make sure that current and emerging connected car challenges are met and overcome," said Goce Talaganov, senior vice president at Mobileum.

Cognata and LeddarTech validate self-driving tractors

Cognata's simulation software has been integrated with LeddarTech's LeddarVision sensor fusion and perception technology to accelerate testing of self-driving agriculture vehicles.

This delivers realism in training and validating adas and AV performance with accurate sensor simulation, bringing AI-powered traffic agents, based on real-world behaviour, and realistic virtual worlds together on a cloud-based platform.

AV and adas automation requires a platform that supports end-to-end development from training to testing, to certification and driving.

Autonomous harvesting systems are witnessing huge demand from farm owners. Market for field farming applications is expected to grow from $5bn in 2020 to $20bn in 2025, a CAGR of 34.5%.

"LeddarTech and Cognata share the vision of using large-scale, cloud-based simulation to thoroughly and safely train and test self-driving cars under endless challenging situations," said Ronny Cohen, senior director at LeddarTech.

LeddarTech acquired Israeli firm VayaVision last year. The company provides vehicles with information on the dynamically changing driving environment for safer and reliable autonomous driving. The software encompasses raw data fusion with up-sampling, AI and computer vision and has the redundancy required for functional safety.

The Cognata platform uses artificial intelligence, deep learning and computer vision to create a realistic automotive simulation environment.


Testing self-driving agriculture vehicles



Magna buys Veoneer for $3.8bn

Magna is to acquire automotive safety firm Veoneer for $3.8bn.

The acquisition should strengthen Magna's adas business and provide access to new regions, including in Asia.

Magna expects to operate Veoneer's Arriver sensor perception and drive policy software platform as an independent business unit. In addition, Magna will acquire Veoneer's restraint control systems.

"Veoneer's complementary technology offerings, customer base, and geographic footprint make it an excellent fit with our adas business, and the acquisition strengthens our global engineering and software development talent base," said Magna CEO Swamy Kotagiri.

Veoneer will be combined with Magna's existing adas business and integrated into Magna's electronics operating unit.

"This is a compelling transaction for all stakeholders," said Jan Carlson, Veoneer's CEO. "Combining forces with Magna will allow the combined business to elevate its status as a full-systems adas supplier, which should benefit our customers, supplier partners and ultimately consumers."

• Veoneer is to industrialise Baraja's Spectrum-Scan lidar technology for L2+ to L4 autonomous vehicles.

Veoneer aims to develop, market and integrate a scalable Spectrum-Scan platform from Baraja.

Baraja has robust technology and a roadmap that lends itself to be among the smallest size lidars to enable vehicle integration.

Spectrum-Scan lidar connects a wavelength-tuneable laser to prism-like optics, deflecting the light in different directions to achieve scanning with higher reliability and lower cost. The RMCW technology enables interference rejection and the ability to measure instantaneous velocity, which distinguishes it from traditional time-of-flight approaches.



Acquisition to strengthen Magna's adas business



Sensing provides driver and cabin monitoring

Smart Eye and Omnivision partner on cabin monitoring

Smart Eye and Omnivision have teamed up to provide end-to-end interior sensing for complete in-cabin monitoring.

Smart Eye specialises in interior sensing AI. The joint offering for OEMs enables complete driver and cabin monitoring with videoconferencing applications from an Omnivision OV2312 RGB-IR sensor supporting day and night use.

"Interior sensing AI is crucial for the automotive industry," said Martin Krantz, CEO of Smart Eye. "Not only is this technology improving automotive safety, it is also enabling automakers to provide differentiated mobility experiences that enhance wellness, comfort and entertainment."

Smart Eye's AI-based eye, mouth and head tracking technology provides Euro NCap performance linked with full cabin monitoring and driver monitoring, featuring distraction, drowsiness and incapacitated driver detection, combined with driver identification and spoof-proof processing.

The cabin monitoring also includes occupancy detection for all seats, combined with out of position, seat belt status and forgotten baby detection.

The action detection allows an understanding of occupant actions such as driver hands on steering wheel, interaction with mobile device, calling, drinking and eating. These actions may have an impact on the interaction between the vehicle and the occupant and will be a pre-requisite for higher levels of vehicle autonomy.

"Empowered by our OmniPixel 3-GS pixel technology, the OV2312 is a 2.1MP, RGB-IR, global shutter image sensor that was designed for interior applications, and it strikes a balance with MTF, NIR QE and power consumption," said Brian Pluckebaum, marketing manager at Omnivision.

STM helps Eyeris monitor vehicle occupants

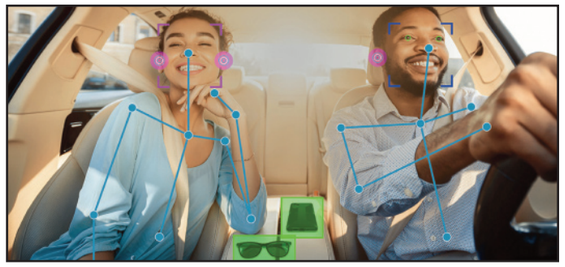
ST Microelectronics is cooperating with Eyeris, a specialist in vision-based artificial intelligence (AI) software and in-cabin sensor fusion technologies.

The collaboration focuses on extending STM's Global-Shutter sensor to in-cabin sensing applications with Eyeris' deep neural networks for a comprehensive visuospatial understanding of the entire vehicle interior.

This perception supports safety and convenience features including driver and occupant monitoring systems (DMS and OMS), child presence detection, object recognition, gesture control, and activity prediction.

STM's 2.3Mpixel VG5761 Global-Shutter sensor has a linear dynamic range up to 98dB for sharp, crisp images. The sensor can capture images inside a vehicle under all lighting and environmental conditions.

With Eyeris' in-cabin sensing technology, the sensor can be used for DMS with accurate eye-gaze tracking, especially from non-frontal camera locations such as rear-view mirror, overhead console and centre stack.



STM and Eyeris monitor drivers and occupants

The sensor also enables Eyeris' OMS with accurate tracking of body key-points, height, width, size, posture, movements and orientation.

Furthermore, the sensor enables child presence detection and recognition of common vehicle interior objects under various lighting conditions.

The sensor's two memory zones allow double-image storage, which, as well as contributing to the high dynamic range, support background removal without lag effects and additional processing by the host system.



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Continental opens software centre in China

Continental has opened an automotive software development centre in Chongqing, China.

"We are programming our organisation for increased growth in China as the world's largest automotive market," said Continental CEO Nikolai Setzer. "The key to success there is local value creation, which we are constantly increasing. Roughly one in ten Continental employees works in China, and they will be joined by a low triple-digit number of software and IT experts at our new development centre by the end of 2021."

According to forecasts, global automotive software sales will multiply from $20bn in 2019 to $50bn in 2030 and China will be the largest market, accounting for around a third of electronics and software revenue.

The technologies developed in China by Continental are embedded in driver assistance systems, for example. They also control computers and customer-friendly vehicle architectures, and enable end-to-end connectivity of vehicle systems.



Continental's software centre in China

"In China, speed is paramount," said Enno Tang, CEO of Continental in China. "With our local development centre for software and systems, we are driving future mobility in the country. It will allow us to act even more flexibly and shorten our route to customers, with whom we will bring automotive trends to Chinese roads even faster. In this way, we will help them to stay ahead of their competitors with our pioneering, innovative technologies."

Intelligent connected vehicles have become a key component of the automotive industry in China, which is why Continental is increasingly driving the local transformation of electrical and electronic architecture to a modern, open mobility architecture.

"Continental is celebrating its 150th anniversary this year and has been active in the Chinese market for 26 years," said Tang. "We have achieved remarkable results here. The new development centre is part of our strategy to further increase value creation in China. This is how we will ensure growth in the Chinese market in the long term."

Fujitsu extends 4Mbit fram mass production

Fujitsu has started mass-production of 4Mbit fram with +125˚C operating temperature, conforming with automotive standards.

Fram is a non-volatile memory with high read-write endurance, fast writing speed and low power consumption; it has been mass-produced for over 20 years.

Mass-production of fram products that operate up to +125˚C started in 2017. Now that has been extended to the 4Mbit MB85RS4MTY, the largest density in the +125˚C family.



Fujitsu fram suits automotive and robotic use

The device meets reliability testing to satisfy AEC-Q100 grade one, and is suitable for industrial robots and adas applications.

This fram with an SPI interface operates at a power supply voltage from 1.8 to 3.6V. In the temperature range -40 to +125˚C, it guarantees ten trillion read-write cycle times and a maximum write current of 4mA at 50MHz. It is housed in an eight-pin DFN package.

Fram can solve problems arising from using eeprom or sram for high-reliability applications.

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Ford and Chevrolet hit worst by chip shortage

Ford and Chevrolet have been the worst hit by the microchip shortage, taking almost 370,000 vehicles out of production, according to market watcher BuyShares.

Car makers across the globe have been struggling to meet customer demand for new cars as the shortage of microchips has led to plant closures and left dealers with a shrinking inventory. US car makers seem to be the worst hit.

When car factories in the USA and across the globe closed in the early days of Covid-19 last spring, many car makers made what has turned out to be a critical error by cancelling orders for microchips.

Although demand for new cars has returned, the microchips, vital for everything from a vehicle's onboard computer to safety features and infotainment system, have been in short supply around the world for months, and the problem could take a couple of years to resolve.

The fire at the Renesas chip plant in Japan, tighter supply chains after the Ever Given grounding in the Suez Canal, and the lack of oil for the plastic used in chips all came as a new shock after the pandemic, causing car makers huge problems with sourcing the microchips.

An AutoForecast report showed Ford had been the hardest hit by the global microchip shortage, taking over 230,000 vehicles out of production. Chevrolet took the second-hardest hit among the US car makers, with its production down by 140,800 cars. Jeep follows with around 138,700.

On worst impacted models, the Ford F series pickup comes first, with its production reduced by 109,710 units. And 98,584 fewer Jeep Cherokees are planned, while Chevrolet Equinox production will fall 81,833, making it the third worst impacted model.

The shortage and the production cuts impacted US car makers' stock prices. The YCharts data show Ford's market capitalisation dropped by $7.8bn in the last month, falling from $63.7bn in June to $55.9bn in July.

General Motors has taken an even heavier hit. The market cap of the US market leader in terms of light vehicle sales plunged by $8.4bn in the last month.

Chrysler Stellantis lost $2.6bn in market cap in this period.

The combined market cap of General Motors, Ford and Chrysler Stellantis plunged $18.8bn in the last month.

Hyundai measures drivers' brainwaves

Hyundai Mobis has developed technology that can measure drivers' brainwaves to detect if their attention is slipping.

After three years of R&D, the M.Brain technology can measures the driver's condition in real time by detecting the brainwaves around the ears through earpiece sensors. The key is the software that analyses and determines the data from the brainwaves.

Machine learning is being used to interpret the brainwave signals.

It can also be interworked with a smartphone app and provide notification that the driver is losing attention.

The accident prevention technology provides alerts for different sensory organs, such as sight (LEDs around the driver's seat), touch (vibrating seat) and hearing (headrest speaker).

The plan is to apply various bio-healthcare technologies to public transportation with a view to contributing to public safety. M. Brain will first test the technology in Gyeonggi-do's public buses.

At CES in Las Vegas in 2018, the company showed its DDREM departed driver rescue and exit manoeuvre, which works to prevent accidents that occur as a result of drowsy driving.



Hyundai headpiece and mobile app for measuring brainwaves

VEHICLE NETWORKS

SETTING STANDARDS



Henry Muyshondt discusses the use of 10baseT1S Ethernet in automotive applications

In existence for almost 50 years, Ethernet and IP-based networks can now be found everywhere, in standard computer networks as well as in automotive, IoT and many kinds of automation applications.

One of the reasons for Ethernet's longevity is its ability to provide scalable bandwidth, ranging from a few megabits per second, right up to multiple gigabits per second, and over several types of physical media. There are also proven software stacks that ensure reliable transmission over the medium.

Users of Ethernet demand security and safety and there are established frameworks for including these aspects into Ethernet-based systems.

The service-oriented architecture of Ethernet helps manage complexity by encapsulating functions and data. A reusable, unified communication mechanism allows many systems to talk to each other easily, as well as ensuring easy movement of services to the appropriate location in the network.

In the past, many different technologies have been used to interconnect dissimilar devices. In the automotive world there are various buses optimised for different applications, such as Lin, Can, Can-FD and Flexray. Their data need to be transferred to ECUs that are often communicating via some flavour of Ethernet. Complex gateway devices are therefore required to communicate between domains.

With each of these technologies using its own hardware interface and implementing different software stacks, EMC between them can vary. By contrast, an all-Ethernet architecture offers many advantages in that the same protocol is used independent of the physical layer – in fact, an Ethernet frame looks the same whether transmitted at 10Mbit/s or 10Gbit/s.

Another advantage is that no complex gateways are needed when scaling the bandwidth for particular applications. Often, a single switch can be outfitted with phy chips that run at different speeds, allowing frames to move seamlessly from one domain to another with no need to modify the data.

Fig. 1 illustrates an all-Ethernet architecture.

An Ethernet switch can use different phys to run ports at different speeds and the data can transfer between the ports without complex translation and gateway requirements.

Fig. 2 illustrates the advantage of the Ethernet architecture.

The phy row indicates that different hardware may be used for different technologies or speed grades but, in the case of Ethernet, the software stack is the same. Even at the hardware level, Ethernet phys tend to use the industry standard Media Independent Interface (MII).

Whether it's in the automotive, industrial or computer markets, using a ubiquitous Ethernet

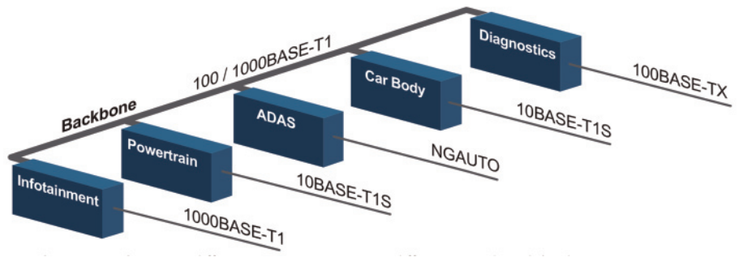


Fig. 1: All-Ethernet architecture

architecture can simplify the design, configuration and control of many different applications, with the same technical expertise able to be used in different markets. The same mechanisms are used no matter how much data need to be transferred, as the Ethernet frame does not need to be modified for different speed grades.

There is also a large ecosystem of hardware and software suppliers that specialise in all aspects of Ethernet communications.

The Ethernet world has already designed architectures to ensure the security and privacy of the information transported over it, building up a body of knowledge on security infrastructure.

IEEE standard

The IEEE has developed a variation of the Ethernet standard that offers a bandwidth of 10Mbit/s over a single pair physical layer. Known as IEEE 802.3cg-2019, the final version of the specification was published in early 2020. This specification expands the breadth of modern Ethernet physical layers at the low end of the bandwidth spectrum.

One of the variants specified under the IEEE standard is 10baseT1S, with S standing for short reach. A long reach variant, called 10baseT1L, is also defined for distances of up to 1km.

This article concentrates on 10baseT1S. This variant originated with car makers that wanted to have an Ethernet architecture throughout the vehicle to simplify and streamline the connections between various domains. Significant cost reductions are achieved by eliminating gateways and by cutting weight by reducing the number of wires running between components.

The 10baseT1S standard uses a multidrop topology, in which each node is connected to a single cable. This eliminates the need for a switch and results in fewer cables. Each cable uses only one pair of wires, instead of the four used in typical Ethernet cabling. The interconnection can even be implemented on a printed circuit board.

At least eight nodes can be connected, but many more are possible. The standard also

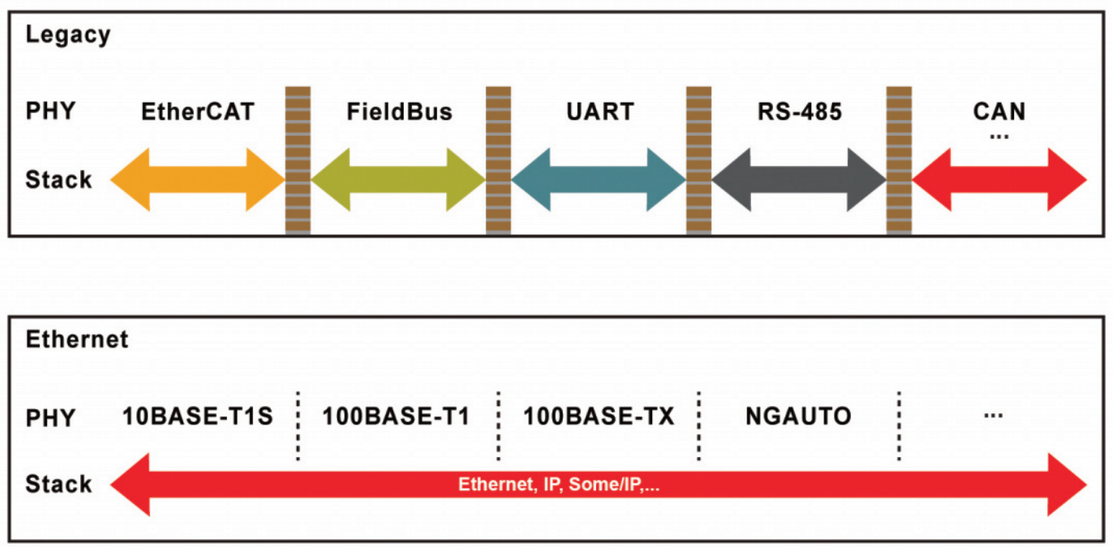


Fig. 2: Advantage of the Ethernet architecture

specifies a bus length of 25m, with 10cm stubs to each node. All the nodes share the 10Mbit/s bandwidth.

Fig. 3 shows the concept of sharing the bus.

PLCA

The standard also specifies an arbitration scheme called physical layer collision avoidance (PLCA), which offers full use of the available bandwidth, while also offering reduced latency and a high quality of service.

Only the phy device that owns the transmit opportunity is allowed to send data when the PLCA is enabled. Transmit opportunities are allocated in sequence, with each phy able to transmit during its transmit opportunity; it can then send a frame of information. A new cycle is started when the master node sends a beacon.

Fig. 4 illustrates the process.

In practice, round-trip delays between two nodes are commonly less than half a millisecond. Almost the full 10Mbit/s is available using the iperf3 tool, which is used to measure maximum achievable bandwidth on IP networks.

Applications

The 10baseT1S technology is getting traction in automotive, building and industrial automation, and computer applications.

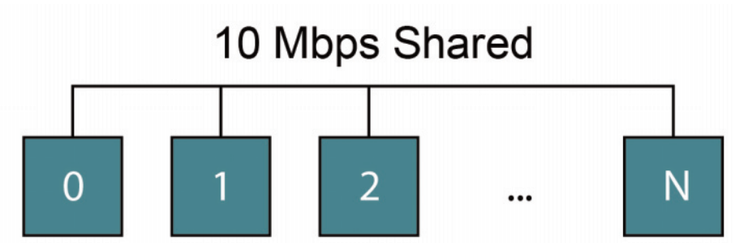


Fig. 3: Concept of sharing the bus

In cars, various sensors require lower bandwidth and benefit from a network architecture. It makes subsystems easier to expand for different trim levels of the vehicle. Many different communication technologies can be consolidated onto a single Ethernet architecture, reducing the number of cables that need to be run to various parts of the vehicle.

Design and development are also simplified and can take advantage of widely available know-how, rather than requiring specialised automotive networking knowledge.

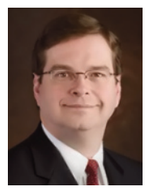
While transmitting power over data lines (PoDL) is not yet fully standardised, work on this technology is in hand. A new IEEE task force is expanding the 802.3cg specification, including adding PoDL. The 10baseT1S physical layer is AC-coupled, making it suitable for carrying power to remote devices.

Conclusion

There are a number of key features for 10baseT1S: multi-drop physical layer; no collisions; efficient use of bandwidth; deterministic and low latency; and security mechanisms.

With these features, Ethernet technology can readily be expanded to new applications; a ubiquitous Ethernet architecture simplifies the design, configuration and control of many different applications.

Components for 10baseT1S are coming onto the market, and new system designs are already underway to implement the technology, while the tools to do this are already available.



Henry Muyshondt is a senior manager at Microchip Technology

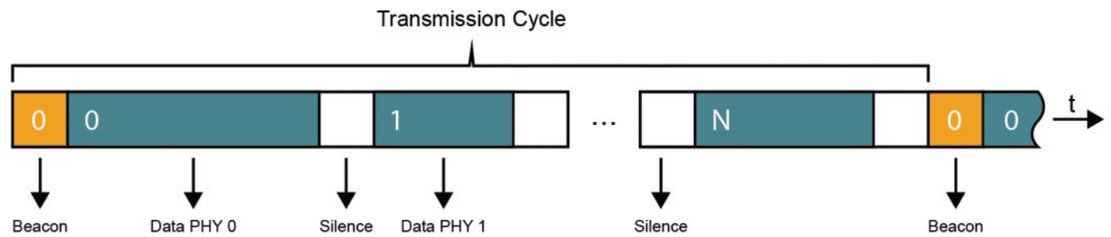


Fig. 4: PLCA process

DESIGN

FLUID MOVEMENT



Bruce Hemp explains how a reflectometer chip can be used in a fluid-level monitor for an automotive windshield washer tank

Fluid-level measurements can be accurately measured through the wall of a non-metallic tank by placing an air-dielectric transmission line up against the side of the tank and sensing the RF impedance. A reflectometer device can simplify the design.

Compared with traditional methods of fluid-level sensing that might involve mechanical floats, the reflectometer-based design offers several benefits, including: fast, real-time fluid-level measurements; extensive electronic postprocessing becomes possible; contactless design so no contamination of the liquid; no moving parts; low radiated RF field; no holes in the tank for an internal sensor, reducing possibility of leaks; and intrinsic safety, due to no electrical wires or parts in the tank.

Fig. 1 shows a block diagram of the overall system, consisting of an RF signal source driving a balanced and terminated air-dielectric transmission line with a reflectometer located in line.

Operation

Transmission lines suspended in air can be designed for precise characteristic impedance and low RF loss as a result of low loss conductors and the lack of solid dielectric material.

Classical plots of E and H vectors show the electric and magnetic fields are concentrated around the conductors, and their magnitude decays quite rapidly with distance, where distance is measured relative to the size and spacing of the transmission line structure itself.

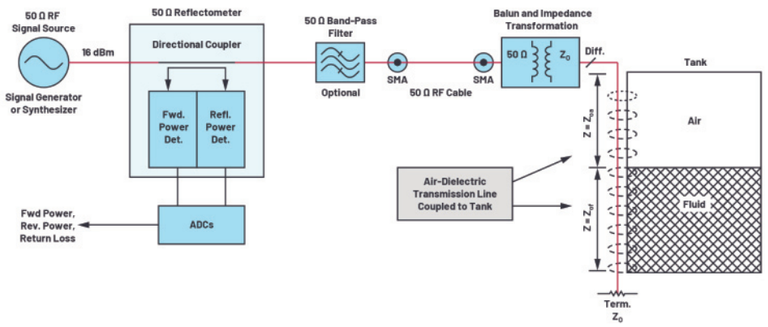


Fig. 1. Fluid-level measurement system block diagram

Any nearby dielectric material such as a fluid tank wall and the fluid within will alter the transmission line's electrical characteristics, which can be summarily measured with a reflectometer.

Description

Consider the case of an air-dielectric, low loss transmission line designed for a specific characteristic impedance Z_O in air. Any added dielectric substance such as a fluid in the near field of the transmission line will lower the characteristic impedance of the transmission line, reduce the velocity of propagation thus increasing the effective electrical length of the line, and increase attenuation of the line.

All three of these effects can combine to create a reduction in return loss, which is directly measurable with a reflectometer device or instrument. With careful design and calibration, return loss can be correlated to fluid level.

To simplify the analysis, consider the air-dielectric transmission line of Fig. 1 with impedance set equal to Z_O before attaching the line to the tank. Because the line is terminated with Z_O, theoretically, there is no reflected energy, and return loss is infinite.

After the transmission line is affixed to the side of a tank, what was one transmission line now behaves as two separate transmission lines, cascaded in a series configuration.

Above the fluid level, the transmission line is air dielectric, except for the tank wall material. Transmission line impedance Z_{OA} is changed little from its air dielectric value, Z_O. The same is true for transmission line velocity of propagation.

Below the fluid level, the transmission line impedance Z_{OF} becomes lower compared with Z_{OA}. Electrical length effectively increases, as does attenuation, all because of the extra dielectric material present in the near field of the transmission line.

The impedance of the termination Z_O at the far end of the transmission line will be transformed when measured by the reflectometer at the source end of the transmission line. The transformation is depicted graphically, approximately as shown in Fig. 2. Because Z_{OF} is lower than Z_O, a clockwise Smith chart rotation is created, as shown by the arrows.

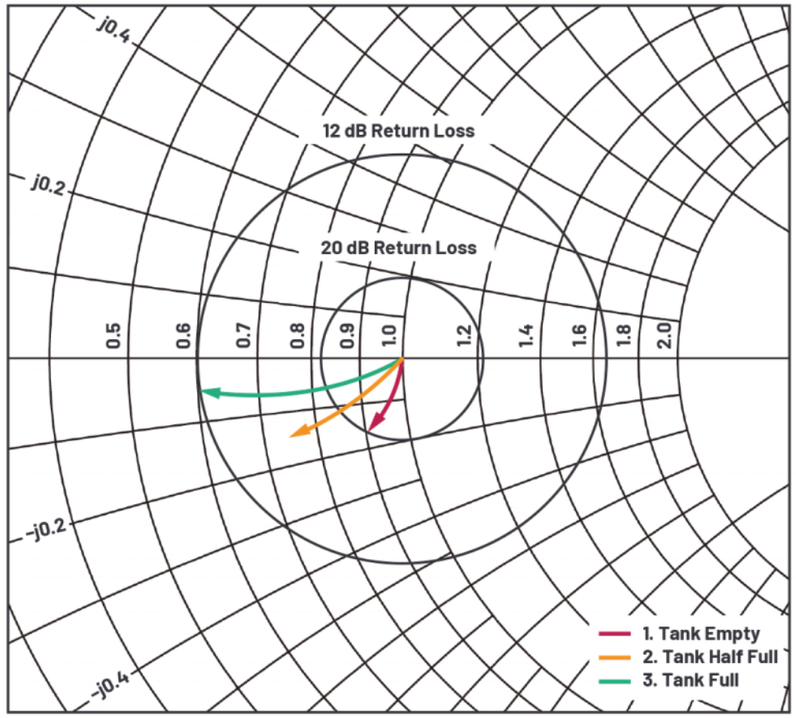


Fig. 2: Expanded, normalised Smith chart representation of transmission line input impedance; trace endpoints depict how fluid level translates to a return loss measurement

When the transmission line impedance is precisely matched to the resistive termination at the end of the line, there shall be no impedance transformation due to the transmission line. This condition corresponds to the centre of the Smith chart, Fig. 2, which shows a normalised impedance of 1 + j0 Ω. Return loss should be at least 26dB before the transmission line is attached to the tank.

After attaching the transmission line to an empty tank, the wall material of the tank will contribute some extra dielectric material to the transmission line, thus lowering the impedance of the line to Z_{OA}, and slightly increasing effective electrical length of the transmission line, Trace 1 in Fig. 2. Return loss should still measure quite well at approximately 20dB.

As the fluid level rises in the tank, transmission line impedance becomes reduced due to fluid displacing a portion of the air as the dielectric transmission. Transmission line impedance that was Z_{OA} now becomes Z_{OF}. Hence, the centre of rotation on the Smith chart moves lower.

Simultaneously, the amount of Smith chart rotation increases, because the effective electrical length of the transmission line is increasing. This is depicted by Traces 2 and 3 in Fig. 2. Consequently, the reflectometer measures reduced return loss at the generator end of the line.

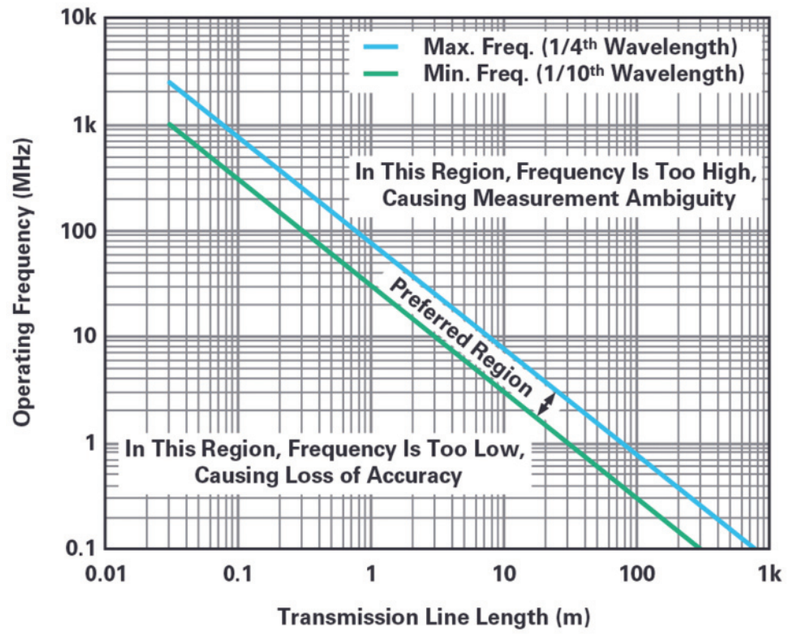


Fig. 3: Recommended operating frequency versus transmission line length

Because the device measures reflection magnitude not phase, the impedance transformation should be constrained to the bottom half of the Smith chart where the reactive component is negative. Otherwise, impedance is being transformed back towards the centre of the Smith chart, causing a magnitude measurement ambiguity. This means the electrical length of the transmission line attached to a full tank should be 90˚ or less. If electrical length exceeds 90˚, the measured return loss will appear to foldback.

A bidirectional RF detector can measure both incident and reflected power in units of dBm, along an RF transmission line of characteristic impedance Z_O = 50Ω. The device can also subtract these two readings, directly measuring return loss in dB.

Return loss

When an RF source is connected to a load, some of the power will be transferred to the load, and the remainder will be reflected back towards the source. The difference between these two power levels is the return loss. It is essentially a measure of how well-matched the load is to the source.

Balun

The balun serves to drive each conductor with equal but opposite polarity AC voltage, and thus serves two primary purposes.

First is reducing stray RF coupling to and from the transmission line. This is

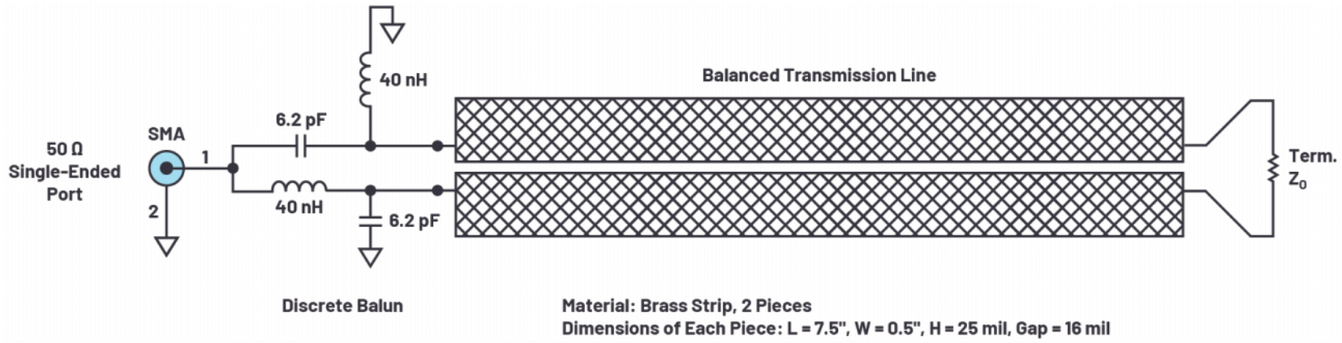


Fig. 4: Balun and transmission line used for fluid level sensing example

important for regulatory emissions and susceptibility compliance. Far-field EMI in either direction is reduced by cancellation.

Secondly is transforming impedance. Higher impedance means wider spacing of the transmission line elements, which means deeper electric field penetration into the container. The result is more change in return loss versus fluid level, which means a more sensitive fluid-level measurement.

The balun should be designed to provide good common-mode rejection ratio over the entire pass band of the band-pass filter.

Band-pass filter

The optional band-pass filter of Fig. 1 is recommended whenever stray RF could couple into the transmission line. A band-pass filter will be very helpful for reducing or eliminating interference from wifi, cellular and PCS services, land mobile radio, and all other outside signals that are not in the same frequency band as the desired source.

For best results, it is recommended that the band-pass filter design features low insertion loss, with return loss commensurate with that of the return loss measurement; that is, approximately 30dB or better if possible.

Design

For the design procedure, choose an operating frequency based on the length of the transmission line. Normally, the transmission line length will be about the same as the tank height or slightly longer.

Operating frequency should be chosen such that transmission line length is typically one-tenth to one-fourth of the RF wave-length in the air.

Fig. 3 illustrates this approximate frequency range. A lower frequency will give the best linearity of return loss versus fluid level, while a higher frequency will give a larger range of return loss signals, but linearity may not be as good, and measurement foldback may occur (Fig. 2). If radiated emissions compliance is required, the frequency may be chosen from the list of applicable ISM frequencies.

Design or choose a balun for the chosen frequency or frequency band. The balun can be a lumped-element LC or transformer based. The balun should exhibit excellent return loss when terminated at the balanced end.

Calculate the conductor width and spacing dimensions of the transmission line. A transmission line impedance calculator such as an arbitrary transmission line calculator is useful for this.

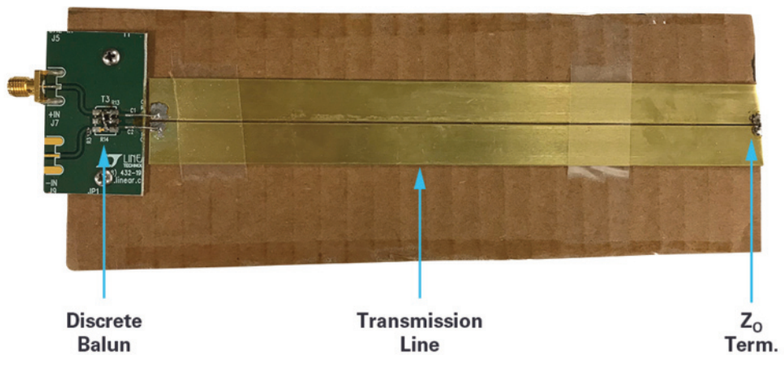


Fig. 5: Discrete balun and terminated transmission line, before affixing to the tank

Windshield washer

For demonstration purpose, a fluid-level monitor for an automotive windshield washer tank was devised. The test setup moves water between two identical tanks, one of which is to have a transmission line attached, for fluid-level measurement.

Because tank height is approximately 0.15m, a target RF excitation of about 300MHz is appropriate, see Fig. 3.

Next, an LC balun was designed and constructed for this frequency range. A slight step-up impedance transformation to Z_O is desired to increase sensitivity to the fluid-level variation, see Fig. 4. A network analyser or reflectometer was used to verify approximately 30dB or better return loss on the single-ended port, with the fixed resistive termination connected directly to the balun, before connecting the transmission line.

A parallel transmission line was designed and fabricated with Z_O equal to the resistor value previously used. The transmission line was connected in-circuit, and the resistor termination moved to the end of the line, see Figs. 4 and 5. The network analyser or reflectometer was again used to verify that return loss remained good, approximately 25dB or better.

Now the transmission line may be attached to the side of the tank, as shown in Fig. 6. It is normal to observe return loss drop slightly when affixed to an empty tank due to the detuning effect of the tank wall material as an additional dielectric layer on the transmission line.

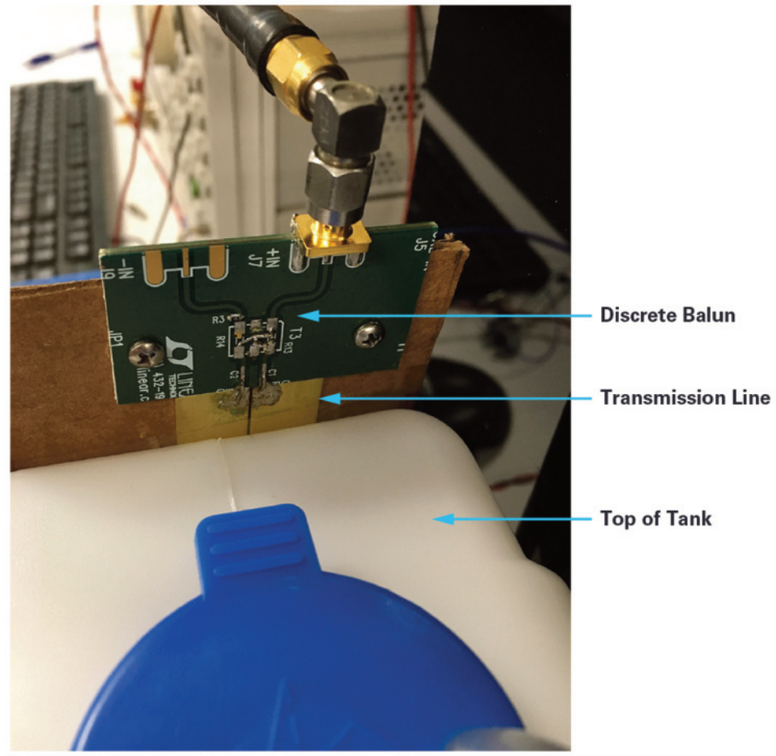


Fig. 6: Example design showing the transmission line affixed to the side of the tank

Test results

Fig. 7 shows a complete test setup. The transmission line is affixed to the side of a tank, and the tank has provision for filling and draining in a controlled manner.

An evaluation kit was used to read the reflectometer measurement results. This evaluation kit included a mixed-signal MCU to read the forward and reflected detector analogue voltages. PC software automatically loaded and displayed results in graphical format versus time. Return loss was easily calculated as the difference between forward and reflected power measurements.

In this design example, fluid-level conditions were established by activating a pump on one of the two tanks. Mass flow rate is relatively constant when a pump is running, so ideally the fluid level in the tank ramps linearly with respect to time. In practice, the tank cross-section was not fully consistent from top to bottom.

Fig. 8 shows the test results as fluid level goes from full to empty. As fluid is pumped out of the tank, forward power holds constant, while reflected power falls relatively linearly.

At t = 33s, a visible change in slope occurred. This is believed to

be due to the design of the tank. The cross-sectional area of the tank was reduced at the lower end of the tank, as seen in Fig. 7, to create space for the pump motor. This introduces a measurement nonlinearity that could be easily corrected in the system firmware if necessary.

Calibration

For best accuracy, reflectometer calibration is required. Calibration corrects for the manufacturing variation of the RF detectors within the reflectometer, namely slope and intercept. The evaluation kit supports individual calibration, as seen in Fig. 8.

At a higher level, the fluid level versus return loss also needs calibration.

This can be due to the following sources of uncertainty: manufacturing variation of the distance between transmission line and tank wall; variation in tank wall thickness; and fluid and/or tank wall dielectric properties could vary versus temperature.

Systematic nonlinearities may exist, for example the change in slope in Fig. 8. If linear interpolation is used, a three-or-more point calibration becomes necessary in this case.

All calibration coefficients will typically be stored in the system's non-volatile memory, which could be unused code space in an embedded processor application, or a dedicated non-volatile memory device.

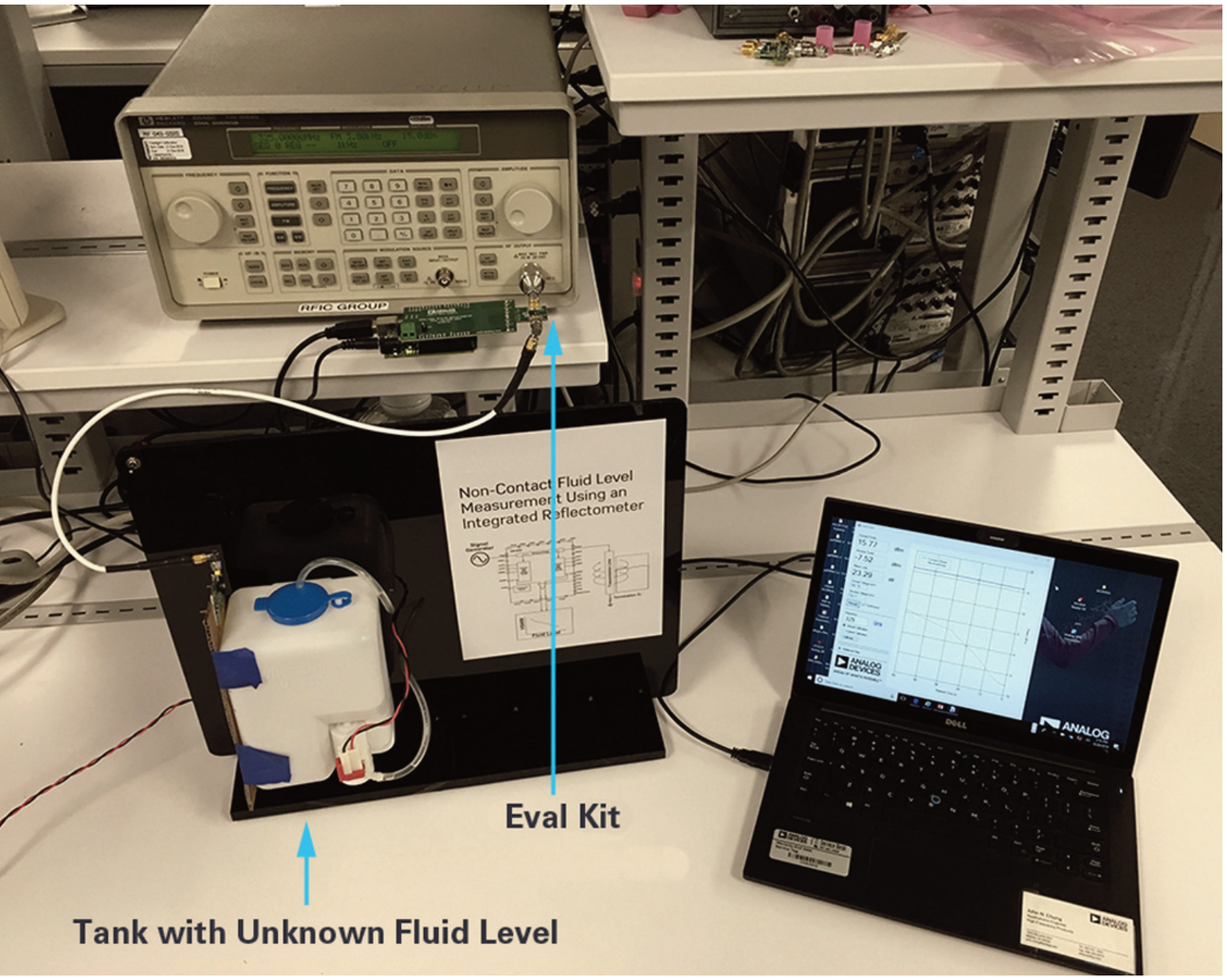


Fig. 7: Complete test setup for the design example

Limitations

Directivity of any reflectometer is a key specification. Neglecting balun losses, when the transmission line is precisely terminated with its own Z_O, reflected power goes to zero, and the reflectometer measures its own directivity specification. The higher the directivity specification, the better the ability of the reflectometer to separate accurately the magnitudes of incident and reflected waves.

For the reflectometer used, directivity was specified as 20dB typical at 1GHz, increasing to approximately 43dB typical at 100MHz or lower.

This makes it suitable for fluid-level measurements where tank height is about 30mm or higher, see Fig. 3.

Extensions

For some applications, the basic contactless fluid-level measurement principle can be extended in several ways.

For example, the measurement may be performed at low duty cycle to conserve power.

If the fluid level is held constant, return loss measurement may correlate to another fluid property of interest; for example, viscosity or pH.

Each application is unique. For example, there are some techniques that might offer better accuracy up at the top end of the scale, compared with the bottom end, or vice versa, depending on the application.

If the tank is metallic, the transmission line will need to go inside the tank. Depending on the application, the transmission line may be submersed.

Measurements at more than one RF power level can help identify if external RF interference is a contributing error. Many single-chip PLL devices support this feature, which becomes a confidence test for the system, or a self-test.

Transmission line sensors on two or four sides of the tank can compensate for container tilt along one or two axes.

If fluid-level threshold measurement is the goal, one or more shorter transmission lines operated at higher frequency can be good.

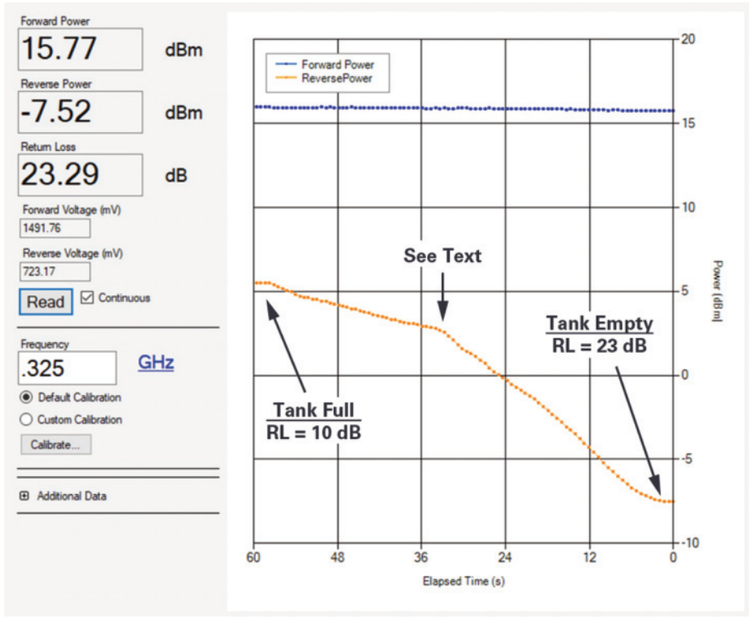


Fig. 8: Example test results versus fluid level; fluid-level measurement is linear and monotonic, with an exception due to tank design

Conclusion

A single-chip reflectometer device brings with it new types of applications, such as fluid-level instrumentation. Eliminating moving parts, such as a mechanical float that has been used for years, will result in a huge reliability increase. Oil- and fuel-level monitoring may also be possible, opening up many industrial and automotive applications.

Acknowledgements

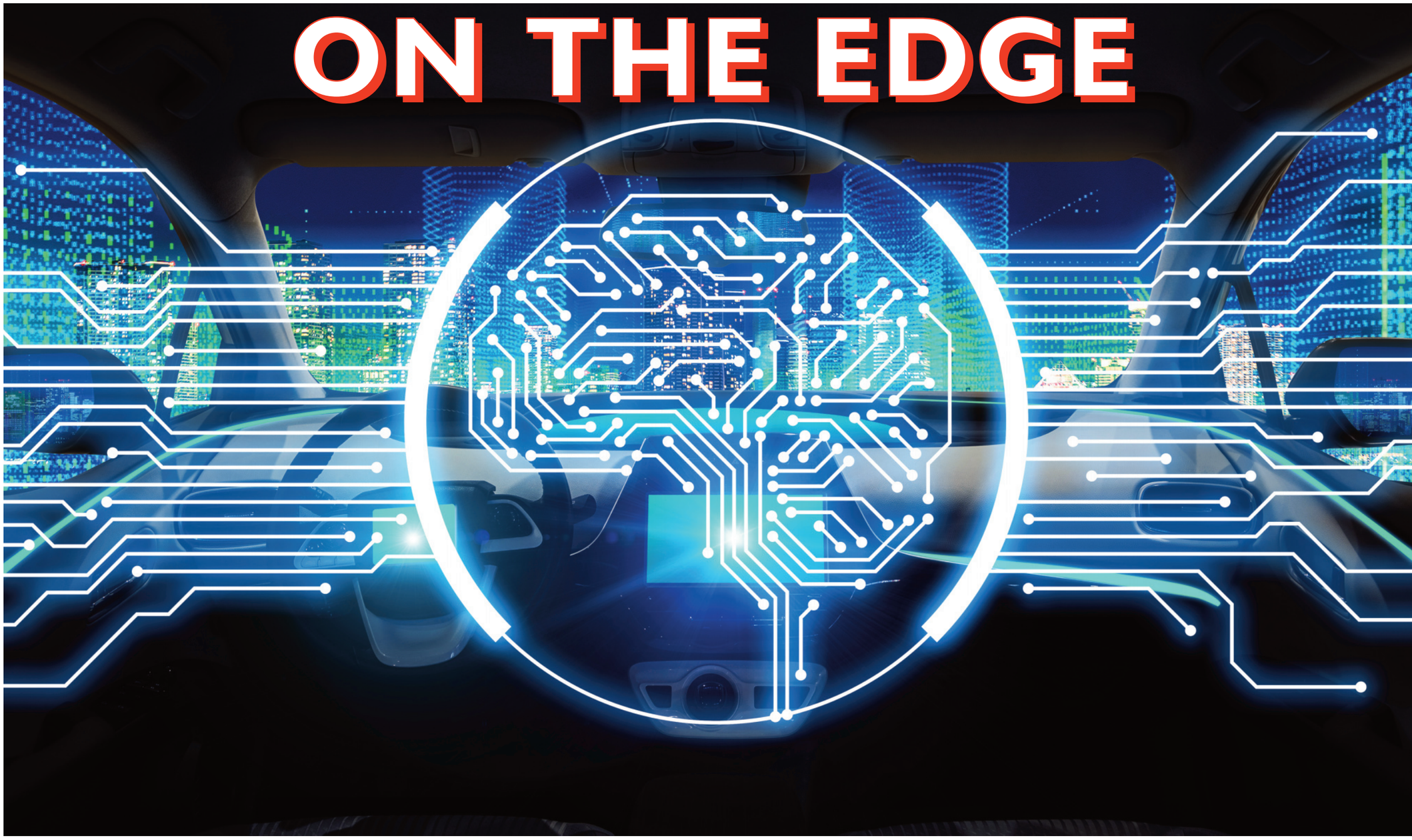
The author wishes to thank Michiel Kouwenhoven, James Wong, Bruce Nguyen and John Chung for their guidance and help with this article.



Bruce Hemp is a senior applications engineer at Analog Devices

ARTIFICIAL INTELLIGENCE

ON THE EDGE



Hilik Stein describes how embedded artificial intelligence can help manage vehicle health

As vehicle electronics and software become increasingly complex, quality issues, recalls and maintenance costs are continuing to grow. To reduce both OEM costs and the total cost of ownership for consumers and fleets, new methods are needed to detect, predict and diagnose vehicle health issues.

Current methods for managing vehicle health generally fall into one of two categories – embedded and telematics-based. Embedded diagnostic detect vehicle health issues using signal processing algorithms and thresholds that were pre-defined during vehicle development. These are limited in their ability to detect unforeseen vehicle health issues, prognose future vehicle health issues, and adapt to vehicle aging and wear.

Telematics can detect and predict vehicle health issues using analytics technologies including artificial intelligence (AI) but, because the AI algorithms are running off-board the vehicle, they are limited by the amount of data that can be cost-effectively uploaded from the vehicle to the cloud.

OEMs and fleets can overcome these limitations by embedding AI-based vehicle health management (VHM) models directly into the vehicle's electronics. Specifically, embedded deep learning based signal integrity monitoring (SIM) can be used to detect complex anomalous patterns and provide highly effective and adaptable vehicle health management capabilities that are not available today.

In addition, by using unsupervised machine learning techniques, OEMs and fleets can simplify the data collection and labelling process that is needed to train the AI-based VHM models.

Embedded AI

AI applications are often implemented as a pipeline of AI algorithms and models that are configured in serial and/or parallel signal paths. These pipelines can use deep learning, and they can be trained to analyse very complex data (inputs) and identify patterns, features, anomalies or other types of valuable information (outputs).

One of the advantages of deep learning is it can analyse large amounts of complex data that typically cannot be analysed using traditional signal processing methods. For VHM applications, deep learning pipelines are very effective at analysing the large number of signals and parameters available onboard the vehicle in real time. But to do this, the pipelines need to be embedded in the vehicle, where they can

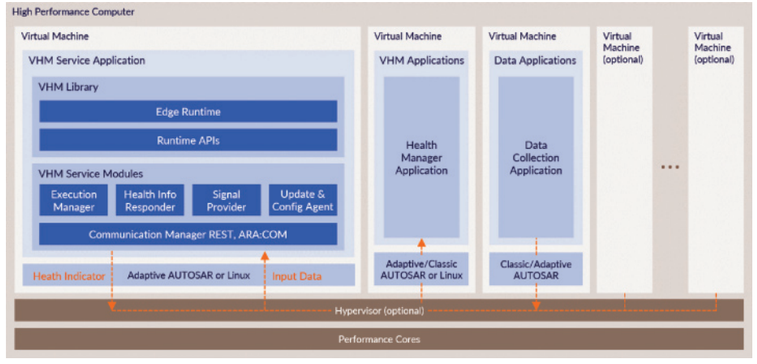


Fig. 1: Embedded AI-based vehicle health management

readily access all of the relevant signals and parameters.

Fig. 1 illustrates a potential embedded AI-based VHM implementation in an automotive high-performance computer (HPC), such as a central gateway module, domain controller or aftermarket telematics device.

In this example, the VHM edge service application runs as an Adaptive Autosar or Linux application and it includes the edge runtime functionality to process the data. The edge runtime supports one or more AI pipelines that provide health indictor outputs. Input data can be provided to the VHM edge service application, and the health information is sent back to the user application using the ARA interface or over TCP.

SIM

Signal integrity monitoring (SIM) is a powerful anomaly detection pipeline that monitors a group of signals and detects complex anomalous patterns and provides signal fault isolation. The inputs to the SIM pipeline are signals that have been generated by the vehicle.

These signals can include sensor outputs, Can bus messages, Automotive Ethernet data and so on. The outputs from the SIM pipeline consist of a health indicator, a change event indicator and a set of signal weights.

As shown in Fig. 2, the health indicator and change event indicator are calculated by the SIM pipeline's scoring and decision models block. The health indictor provides a score for the anomaly level of the system that's being monitored. It is a single score representing the aggregate of all the input signals and it varies in real time as the vehicle's conditions change.

Because it provides a single health score, development engineers will usually design multiple monitors using different sets of input signals to monitor various systems or multiple aspects of the same system.

The change event indicator monitors the health indicator and provides the time at which it changes from a normal health score to an abnormal health score. So, in the event of a health anomaly or failure, the engineer or technician can see exactly when the vehicle's health condition changed.

The third SIM pipeline output is a set of signal weights that can be used for root cause analysis. By using explainable AI techniques, the SIM pipeline calculates causality metrics that help explain the results of the deep learning neural network, which is typically seen as an inscrutable black box.

The explainer models block in Fig. 2 analyses the causalities and relationships between the different input signals and, through that analysis, creates weights for each of the signals. If an anomaly is detected, then these signal weights show the correlation of each signal to the anomaly, which can then be used to determine the root

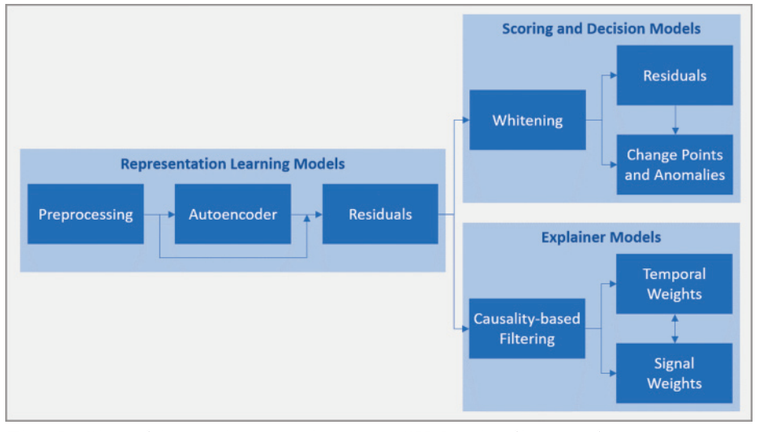


Fig. 2: Signal integrity monitoring (SIM) pipeline architecture

cause of the vehicle's health issue.

One of the key features of the SIM pipeline is it uses an autoencoder type of neural network, which can be designed very efficiently and trained in an unsupervised manner. By using unsupervised training, the entire pipeline can be trained using normal vehicle data. This means the SIM pipeline is trained only using data from a healthy vehicle, data that do not have any anomalies.

This greatly simplifies the data collection process and automates the training process, since it eliminates the need for development engineers to degrade the vehicle's performance intentionally to collect training data with anomalies. In addition, the SIM pipeline is adaptive. This means it can learn and adapt to vehicle aging and wear throughout the vehicle's lifecycle.

Results

Fig. 3 shows the SIM pipeline outputs for an air-fuel ratio (AFR) monitor. In this example, 14 signals were identified and collected from an internal combustion engine vehicle. Using unsupervised deep learning technology, the AFR monitor was trained with normal vehicle data. After the AFR monitor was trained and validated, a vacuum leak was introduced that degraded the performance of the engine.

As shown in Fig. 3, the health indicator showed a clear distinction between the test vehicle's normal behaviour and its anomalous behaviour during the test. The change event indicator pinpointed the time at which the anomaly appeared. And the signal

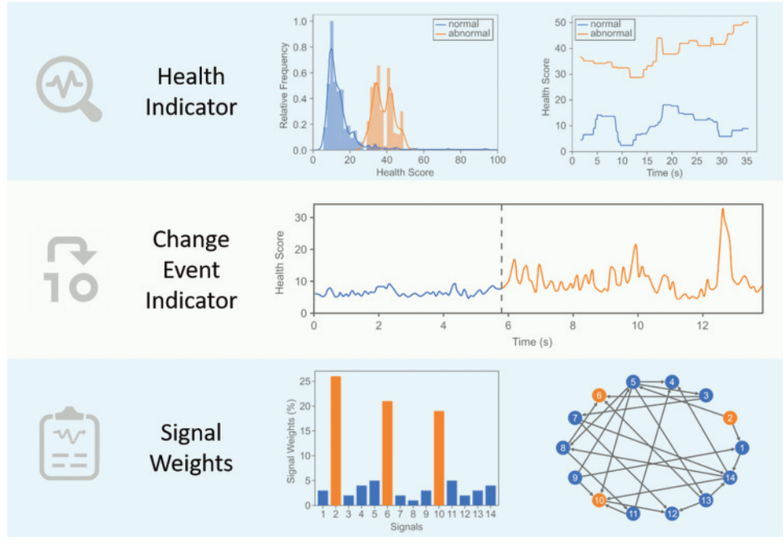


Fig. 3: SIM pipeline outputs

weights helped identify three signals as the main contributors to the anomaly.

It should be noted that during this test, the engine controller never triggered a DTC (diagnostic trouble code), and the check engine lamp was never illuminated. If left uncorrected, this issue would result in increased fuel consumption, cause more pollutants to be emitted into the environment, and potentially damage the vehicle's engine.

However, by using a SIM pipeline at the edge, the degradation in the engine's performance was detected by the AFR monitor before the vacuum leak became a serious health issue.

Conclusion

To detect vehicle performance degradation and predict future health issues, AI-based vehicle health management must be moved to the edge, where it can access large amounts of vehicle data in real time. An anomaly detection pipeline that uses an autoencoder type of neural network, such as SIM, is an effective method for providing these capabilities.

By using unsupervised deep learning technology, the data collection process can be simplified, and the neural network training can be automated. In addition, the SIM pipeline can learn and adapt to vehicle aging and wear throughout the vehicle's lifecycle.

Diagnostic capabilities can be further enhanced by using a change event indictor to determine the timing of the vehicle health issue and by using explainable AI techniques to help determine its root cause.



Hilik Stein is the CTO and co-founder of SafeRide Technologies

RESEARCH & DEVELOPMENT

BEHIND THE WALLS

A look inside Nissan's research centre in Japan



Thinking towards the future is something Nissan has always been proud of. At the core of its forward-thinking attitude are the inquisitive minds of its people, particularly researchers.

These bright individuals challenge themselves day in and day out, chasing their dreams and solving problems, pushing boundaries in the process.

The research centre is located across two sites in Kanagawa prefecture. The older of the two buildings dates back to 1958, a hint of just how long Nissan has been investing in R&D. It is here that a lot of Nissan's technological development begins.

The key objective for those involved is to develop technologies leading to practical applications for Nissan. This involves identifying trends and analysing future needs.

The process can be divided into four focus areas: driving electrification towards carbon neutrality; developing mobility services for new value creation; expanding AI use beyond cars and into production; and innovating production technologies for vehicles of the future.

The research centre serves as a compass for Nissan. It is a meeting-point for researchers bound by the same inner drive to change the world via new-value technologies.

3D printing

Moe Mekata has been three years with Nissan. She is a 3D printing materials researcher.

Since her university days, she has been interested in production technology, and decided to join Nissan, rather than other manufacturers in different industries because car production involves a variety of manufacturing processes.

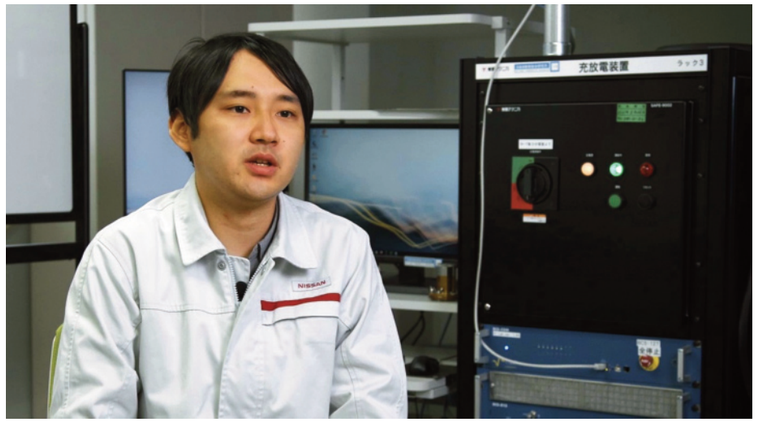
With a sparkle in her eye, Mekata said: "Making metal parts with 3D printers changes the world of car manufacturing. This is because 3D printers can produce parts of any shape without a mould. This allows us to reduce weight by utilising a 3D structural model and component integration. In addition, 3D printers enable us to vary the strength of a part or its materials like aluminium or iron depending on the part itself or its required performance. It's a dream! We'll soon be able to create specific parts as requested by engineers."

The material used in this kind of 3D printing is metal powder. The grains that make up the powder are piled up, fused layer by layer, and formed into a single piece. Unlike conventional parts production – which requires casting, cutting and welding – this method reduces waste.

Mekata's research focuses on the development of the metal powders used in the process. One of the challenges leading to commercialisation is to improve the quality of the powder while keeping costs low.

3D printers have gained attention not only for their efficiency and the improvement of overall production quality, but also because they serve an important role in supporting Nissan's efforts to achieve carbon neutrality.

3D-printed parts can make electric vehicles (EVs) lighter, and thereby increase driving range. This is especially important because EVs tend to be heavier due to the battery packs they carry. By unifying the parts creation process, which previously relied on a multi-stage



Kazuhiro Yoshino: “We challenge ourselves every day.”

method, 3D printers optimise the shape of the part in a single step, reducing waste material.

“It’s the overall powder quality that determines the final performance of the 3D printed parts,” she said. “That’s why we’re aiming to develop new, high-quality powders that no one else has put into practical use.”

Solid-state batteries

Hiroki Kawakami has been seven years with Nissan and Kazuhiro Yoshino four years with the car maker.

All-solid-state batteries represent the next-generation of batteries. Kawakami and Yoshino are working to achieve a breakthrough for the practical application of this battery technology. Kawakami is collaborating with researchers and students from around the world at Purdue University in the USA, while Kazuhiro is working with researchers at the Japanese research centre.

Lithium-ion batteries used in many EVs have a liquid electrolyte that conducts lithium-ion. In contrast, the electrolyte in an all-solid-state lithium-ion battery is – by definition – solid. But why is this new type of battery attracting attention?

“The biggest advantage of all-solid-state batteries is the significant increase in energy density,” said Yoshino. “By using electrode materials that store more lithium-ion and electrons, more energy can be stored in a smaller volume. If this battery is used in EVs, we can expect dramatically increased range. The solid electrolyte could also make charging faster. For these reasons, all-solid-state batteries will be key in accelerating widespread use of EVs.”



Hiroki Kawakami: “We discuss difficult issues daily.”

As part of Nissan’s overseas assignment programme for young researchers, Kawakami conducts daily simulations to investigate what is happening inside the battery and its performance. He sends this information to the Nissan research centre, where Yoshino uses it to make a prototype and test as an actual, physical battery. Together with his colleagues, he conducts experiments to determine if the target performance is achievable.

So, what kind of breakthrough is needed for the practical application of all-solid-state batteries?

“One of the most difficult aspects of developing all-solid-state batteries is the contact between active material particles, which store lithium-ion in the electrodes and the electrolyte particles, through which the lithium-ion passes,” Kawakami said. “For better contact, we need a machine that applies high pressure from the outside. The key is to ensure sufficient contact, even at low pressure, between the active material of the electrodes and the electrolyte. We’re working hard every day to find a solution to this problem through a process of trial and error.”

He said there were still many things researchers did not know about what happens inside the battery.

“To understand it completely, there are a number of issues we still need to solve,” he said. “We discuss these difficult issues daily with local researchers and students, each of whom have different ways of thinking, and then exchange our views. It’s great when everyone gets on the same page to solve a problem.”

Yoshino – who has been researching the all-solid-state battery since his university days – thinks one of the best things about Nissan is that the company listens to young people and lets them tackle a problem for themselves.

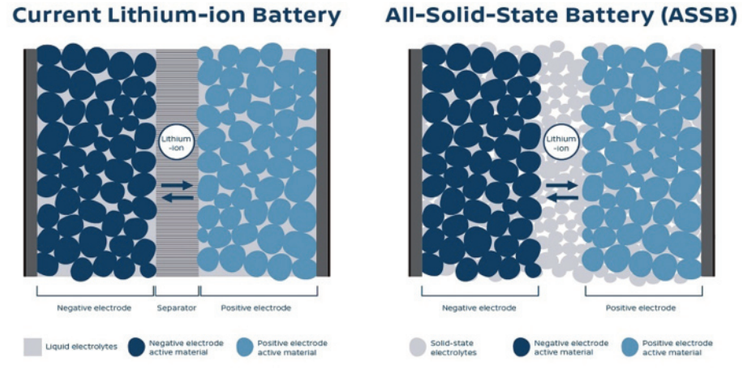
“My fellow young researchers and I challenge ourselves every day,” he said. “Words cannot express the feeling we get when we achieve the performance we are aiming for.”

Within the encouraging atmosphere of the research centre, these three young researchers plan to keep on pushing themselves to achieve their aims and deliver future technologies.

RESEARCH & DEVELOPMENT



Moe Mekata: “It’s a dream!”



Comparing a current Li-ion battery with an all-solid-state version

Radar tester simulates driving scenarios

A radar test system from Rohde & Schwarz simulates driving scenarios for testing radar based adas and radar sensors used in autonomously driving (AD) cars entirely over the air.

It consists of the AREG800A automotive radar echo generator as a backend and the QAT100 antenna array as a frontend.



Objects approaching from the side are usually simulated by mechanically moving antennas. This replaces the mechanical movement by electronically switching individual antennas in the frontend on and off. Even objects moving laterally to the car at very high speed can be simulated.

The tester can simulate the radial velocity (Doppler shift) and the size (radar cross section) of objects at user configurable ranges. Countless objects can be represented by cascading multiple backends. This moves tests performed on the road to the lab, allowing early error detection and a reduction in costs.

The latest radar sensors come with integrated RF antennas and signal processors for object recognition on the same chip. That is why the objects to be recognised need to be simulated over the air in radar sensor tests.

The target simulator generates dynamic radar echoes that can be used at all stages of automobile radar sensor testing from pre-development through hardware-in-the-loop lab tests to validation of adas and AD functions integrated in the vehicle.

The backend can simulate a large number of independent artificial objects and dynamically vary their range, size and radial velocity. With an instantaneous bandwidth of 4GHz between 76 and 81GHz, it covers the typical frequency range of current and future automotive radar sensors.

The frontend uses up to 192 independently switchable antennas to simulate objects moving laterally. Electronic switching of the antennas does not cause any wear to RF cables and other moving parts. An optional transmit array makes it possible to simulate two objects very close together and moving laterally to the car.

The small patch antennas and the absorber-lined surface provide a low-reflection RF frontend with a small radar cross section. This reduces the sensor's noise floor and suppresses close-range targets and potential multipath reflections.

The antenna spacing of 3.7mm delivers fine angular resolution. Multiple frontends can be combined to cover larger fields of view of radar sensors. An angular resolution of less than 0.5° is possible.

Starting from simple scenarios such as automatic emergency braking, the tester can be extended to cover complex scenarios with multiple radar sensors thanks to its modularity and scalability.

Any number of frontends and backends can be combined. One backend synchronises all the components installed in the setup. A graphical user interface with a touchscreen makes it easy to configure the test setup.

It comes with a hardware-in-the-loop interface conforming to the Asam open simulation interface specification.



Reference design meets Qi 1.3

To meet the requirements of the Wireless Power Consortium (WPC) Qi 1.3 specification that requires authentication for improved safety when transmitting up to 15W between a transmitter and a receiver, Microchip has announced a wireless charging reference design.

This provides developers of wireless charging systems for automotive and consumer applications with the tools and support for seamless integration and certification.

The three-coil Qi 1.3 reference design integrates secure storage subsystem software with the wireless power microcontroller and enables custom topologies and foreign object detection.

Qi 1.3 is a significant update from Qi 1.2.4 and mandates hardware-based authentication between transmitter and receiving devices for power transfer above 5W. By adhering to the authentication standard, designers can ensure phones receiving 15W are receiving it from a Qi-certified authenticated transmitter to ensure safety.

Included in the reference design are Qi controller, Qi application software, provisioned authentication controller that is a WPC-approved secure storage subsystem, and crypto software libraries that execute on the Qi controller.

The reference design includes complete schematics, bill of materials, software and design guidelines.

To support this, Microchip is providing the DSPic 33C family of devices to run the Qi application software and the ECC608/TA100 secure storage subsystem.

It also incorporates Mic 4605 and MCP14700 gate drivers, MCP16331 and MCP1725 regulators, MCP6C02 current sense device, ATA6563 Can transceiver, and MCP-9700 temperature sensor.

The wireless charging reference design is available for demonstrations and evaluations for qualified customers.

LDOs simplify functional safety

With eight selectable fixed-output voltages, diagnostic features for functional safety and high thermal performance, ST Microelectronics' L99-VR01 AEC-Q100-qualified low-dropout linear voltage regulators can simplify system design and ease inventory management for multiple automotive applications.

The regulators supply up to 200mA for powering body modules, junction boxes, instrument clusters, sunroof controllers, keyless-entry controllers and sensors.

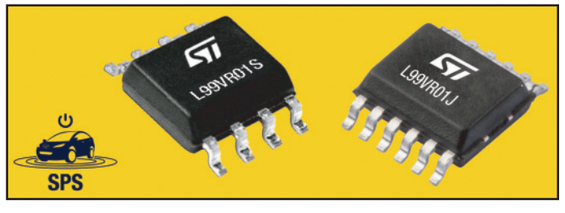
Output voltage can be set to 0.8, 1.2, 1.5, 1.8, 2.5, 2.8, 3.3 or 5V more accurately than with an external voltage divider using three external selection pins. The output is within ±2% of the nominal value.

Two versions are available. The L99VR01S comes in a standard SO-8 package with enable and reset pins as well as safety features such as fast output discharge, under-voltage lockout, thermal shutdown and short-circuit protection. The quiescent current is reduced to 1μA when disabled and the regulator operates from -40 to +150°C.

The L99VR01J in Power SSO-12 additionally allows programming of the short-circuit current limit, provides thermal warning and output-overvoltage status indications, and contains a programmable watchdog that checks for correct operation of the host microcontroller. Operating junction temperature is from -40 to +175°C.

By integrating output overvoltage monitoring, the regulators can provide constant load protection. Diagnostic features help users achieve the required ISO 26262 Asil value.

Both have an input-voltage from 2.15 to 28V, for use connected directly to the battery voltage or for post-regulation to convert an already regulated voltage. The inputs are 40V tolerant to withstand load dump.



Current sensors handle 3.3 and 5V

Current sensors from Melexis have optional 3.3 or 5V operation and integrated over-current detection circuitry.

The MLX91219 is a conventional Hall current sensor. Using a ferromagnetic C-core, currents can be measured from 200A to beyond 2kA. The MLX91218 is an IMC-Hall current sensor. With a flexible U-shield for crosstalk immunity, currents can be measured from 200A to 2kA.

Both have a signal-to-noise ratio nearly two times greater than preceding generations. Linearity is within ±0.3% of full scale.

The AEC-Q100-qualified sensors are accurate enough to manage high-speed applications such as motor control, inverters and converters, but also redundant monitoring of battery-management systems.

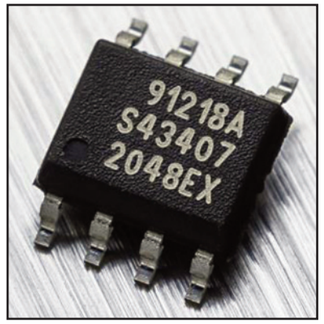
Thermal drift maintains electrical offset within ±5mV and sensitivity within ±1% to ensure accuracy over a wide temperature range.

Designers can use these sensors directly in circuits containing 3.3V low-voltage microcontrollers or with legacy 5V devices.

They integrate over-current detection circuitry typically implemented off-chip using an external window comparator, thereby simplifying design, saving board space and reducing costs.

The over-current threshold is set internally during initial product configuration.

The future soic-8 packaged products have an additional pin that allows setting the threshold voltage with increased accuracy using an external voltage divider. Two indicator pins show the over-current status in relation to internal and external thresholds, with 2 and 10μs response times, respectively.



A selectable analogue output allows the choice of a fixed output or ratiometric output that scales with the supply voltage.

With 400kHz bandwidth and fast response time, they are suitable for circuits designed to operate at high switching speeds and fundamental frequencies to reduce phase delay in the control loop.

In addition, the MLX91218 incorporates a patented integrated magnetic concentrator to optimise magnetic field shaping, which allows compact, lightweight shielding.

The MLX91219 is available in a four-pin sip.

The MLX91218 and the small-outline SOIC8 package for MLX91219 will be available soon.

IP simplifies ISO 26262 compliance

To help make a chip meet ISO 26262, Sondrel has launched a quad-channel, IP reference platform that simplifies and speeds the creation of the required evidence bundle.

The semi-custom SFA 350A IP platform has been designed for adas used to support driverless or automotive vehicle applications.

It has four channels for sensors that can be either passive, such as optical via camera inputs, or active using laser or radar. This can be cost-effective compared with having a dedicated, one channel chip for each sensor.

Uses include collision avoidance, detection of crossing the central white line or gathering 3D information via a pair of cameras.



The IP is scalable due to its framework architecture design. This lets the processor units for the chip's four channels be selected according to the processing power required by the application without requiring any changes to the interconnects and IO to the rest of the chip.

This modular approach makes the platform versatile and scalable. More powerful options can be created by ganging identical SFA 300 quad-core chips together to form a cluster.

DC-DC converters

With its Value DC-DC product line, BrightLoop offer converters for off-highway and commercial vehicles. It is teaming up with EPC on a line that will be available towards the end of the year.

Using GaN technology, the line is composed of two converters (M and L), respectively delivering 6kW/300A and 12kW/600A. Weight is less than 5kg. They comply with ECE R 10, ECE R 100 and LV 124.

The converters can be used in 12, 24 and 48V architectures and with 400V, 800V or more exotic battery ranges.

Available in single or dual output versions, the output voltage can be set by Can between 1 and 54V. This allows the removing of some components such as the battery equaliser, present when there are several batteries.

A reversibility function pre-charges the HV bus without the need for bulky resistors.

These features are made possible by the use of EPC's EPC2029 enhancement-mode GaN fet. This is an 80V, 48A fet with a 1mm ball pitch. The wider pitch allows for placement of additional and larger vias under the device to enable high current carrying capability despite the 2.6 by 4.6mm footprint.

Speed sensor measures gear rotation

A giant magnetoresistance (GMR) speed sensor from Allegro Microsystems measures the rotation of ferromagnetic gears.

The ATS19480 IC provides a single-channel for hybrid and pure electric vehicle transmissions, with use cases extending to two-wheelers, off-road vehicles and industrial applications.

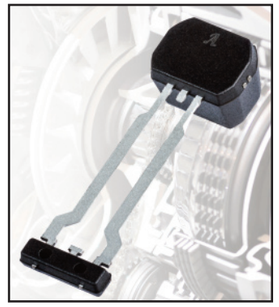
Combining GMR technology with automotive grade algorithms and packaging, the device adds a speed-only protocol to the firm's recently released ATS19580 transmission speed and direction sensor IC.

With an air gap that's 50% larger than existing options, it can improve design-in flexibility, expand design margin and tolerance capability, and facilitate a wider range of sensor installation locations.

Both complement the firm's ATS-19420 and ATS19520 integrated Hall-effect speed sensors, as well as its front-biased Hall-effect and GMR products for magnetic target sensing.

Monolithic integration makes it possible for the ATS19480 to boost in-system performance and speed detection. The single over-mould package lessens design complexity and simplifies the development process.

Enabling flexible design-in and system compensation, the package houses the IC, magnet and EMC protection. The assembly optimises IC-to-magnet positioning, as reduced tolerance stack between the IC and magnet increases sensor accuracy and leaves margin for in-application installation tolerance.



Signal compensation eliminates flatline conditions caused by dynamics, and differential sensing protects against common-mode stray fields.

It includes integrated Asil-B diagnostics and certified safety design process for fault reporting, and operation under harsh operating conditions can help reduce failure rates.

Voltage monitor aids functional safety

Designers working to achieve automotive functional safety in adas can reduce size and complexity with the Max 16137 single-window voltage monitor with built-in self-test (bist) from Maxim Integrated.

This window monitor IC delivers protection by tracking undervoltage and overvoltage levels with 1% accuracy so designers can accelerate system-wide functional safety by providing diagnostics and reset capabilities.



Functional safety standards drive design direction in the automotive space. Voltage monitors play a role in reporting the health of power supplies. These systems must include test circuits to ensure reliable operation.

The Max 16137 delivers diagnostic and bist at chip level to help designers achieve system-wide functional safety faster for adas and other autonomous driving uses.

Dual power rail GPIO expanders

Bidirectional voltage-level translation GPIO expanders from Diodes suit automotive use.

The 16bit PI4IOE5V6416Q and 34bit 6534Q are AEC-Q100 grade-two devices with dual voltage rails and provide programmable IO for low voltage microcontrollers via the I²C interface.

The devices provide engineers with an option when additional IOs are needed while keeping interconnections low, for example in adas, telematics and infotainment.

Removing the need for an external voltage-level translator can simplify the design of adas and telematics, and reduce cost.

Both operate from 1.65 to 5.5V on the GPIO port side. On the SCL and SDA side (I²C interface), the 6416Q operates from 1.65 to 5.5V and the 6534Q from 0.8 to 3.6V.

This dual power rail lets the devices interface with low-power microchips on the SCL and SDA side.



Standby current consumption is 1.5μA at 5V and 1μA at 3.3V for the 6416Q and 2μA at 3.3V for the 6434Q.

Each 16 or 34bit GPIO is configurable, and each port has a programmable pull-up or -down resistor and a programmable output current. They also provide programmable open-drain outputs.

A feature lets the designer mask the interrupt from an individual GPIO port and initiate a system-level action.

The 6416Q is packaged in a 24-pin tssop and the 6534Q in the W-QFN4565-46 package. Both support PPAP documentation and are manufactured in IATF 16949 certified facilities.

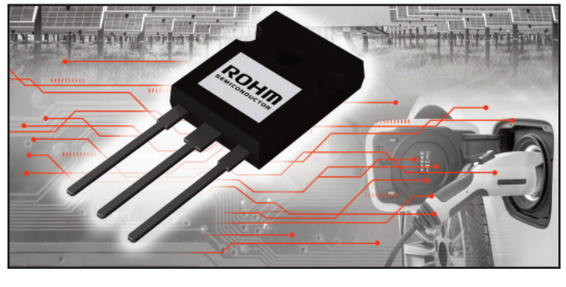
IGBT integrates SiC Schottky diode

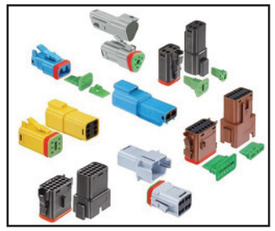
Rohm has developed a hybrid IGBT with an integrated 650V SiC Schottky barrier diode.

The RGWxx65C meets AEC-Q101 and is for automotive and industrial applications that handle large power, such as photovoltaic power conditioners, onboard chargers and DC-DC converters in electric vehicles.

The SiC diode is used in the IGBT's feedback block as a freewheeling diode that has almost no recovery energy and thus low diode switching loss. Since the recovery current does not have to be handled by the IGBT in turn-on mode, the IGBT turn-on loss is reduced.

Both effects result in up to 67% lower loss over conventional IGBTs and 24% lower loss compared with super-junction mosfets in vehicle chargers.





Sealed connectors

For commercial vehicles in harsh environments, TE Connectivity has expanded its transportation portfolio with the DT-XT sealed connector.

The sealing materials and covalent bond increase flexibility to improve tear resistance and seal positioning. A rear sealing cover protects against water ingress. The design works with standard tools and eliminates the need for costly redesigns. They are IP69K-rated and J2030 power-wash tested.

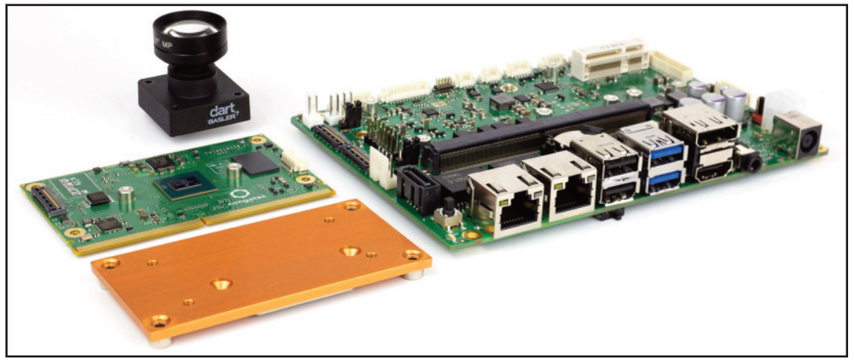
An integrated lock provides secure mating and electrical connection in the vehicle. Finger grips on the locking mechanism provide a ribbed surface to make it easier to connect, disconnect and release when fingers are wet, dirty or oily.

Crimp terminals lower insertion and withdrawal forces.

The connection system comes in various colours and custom options, enhancing poka-yoke and removing the need for labelling of wires.

Starter kit enables AI embedded vision

A starter set from Congatec is for AI accelerated intelligent embedded vision applications such as in-vehicle vision for navigation and surveillance systems in buses.



Based on a Smarc computer-on-module with i.MX 8M Plus processor, the set uses NXP's neural processing unit (NPU).

Delivering up to 2.3Tops for deep learning based artificial intelligence, it can run inference engines and libraries such as Arm's NN neural network and TensorFlow Lite. It also integrates seamlessly with Basler embedded vision software to give OEMs an application ready platform for AI accelerated embedded vision.

The Basler pylon camera software delivers a unified SDK for BCon for Mipi, USB3 vision and GigE vision cameras, and enables camera access from source code, gui or third party software. The pylon viewer is suitable for camera evaluation.

Engineers get instant access to AI supported machine vision features such as triggering, individual image capture, and differentiated camera configuration options plus easy access to custom inference algorithms.

At the heart of the set is the Smarc 2.1 Conga-SMX8-Plus computer-on-module. It has four Arm Cortex-A53 cores, one Cortex-M72 controller and the NXP NPU to accelerate deep learning algorithms and comes with passive cooling.

The 8.9cm Conga-SMC1 and Smarc-Arm carrier board directly connects the 13MP Basler dart daA4200-30mci BCon for Mipi camera with an F1.8 f4mm lens via Mipi CSI-2.0 without additional converter modules.

USB and GigE vision cameras are also supported.

On software, there is a bootable SD card with preconfigured boot loader, Yocto OS image, matching BSPs and processor-optimised Basler embedded vision software enabling immediate AI inference training based on captured images and video sequences.

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