Driving the Future: Enhancing Electric Mobility and Vehicle Safety with Murata's Charging and Sensor Technologies

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INNOVATOR IN ELECTRONICS

Index

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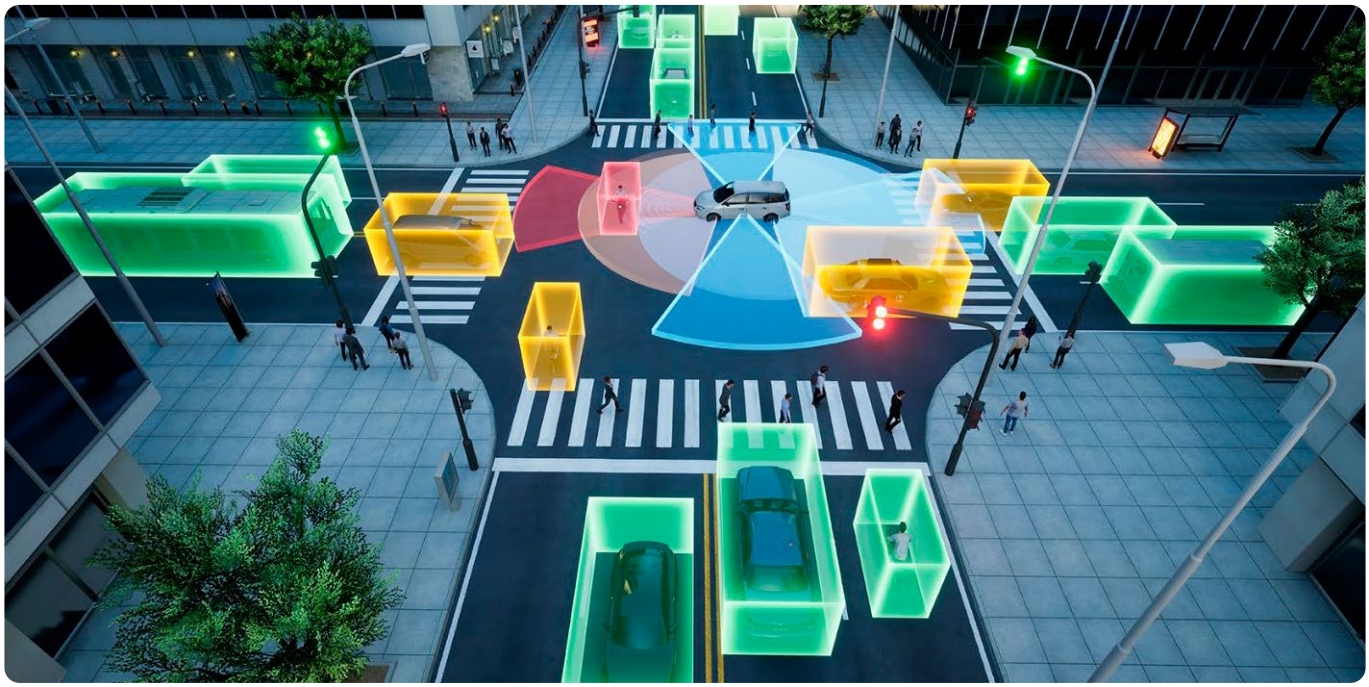


In the mobility sector, there is an unprecedented mix of opportunities and obstacles – never before has the market been more dynamic. Electric vehicles (EVs) have undeniably established themselves and have demonstrated remarkable sales figures over the last five years. The total number of EVs on the roads has now reached over 40 million, with registrations of nearly 14 million new cars in 2023.[1]

But the sector is far from straightforward. The traditional hierarchy is being confronted by a range of new manufacturers, including both Tesla, the early pioneers of EVs, and the numerous emerging Chinese OEMs. Other disruptions across the transport industry have also occurred due to electrification and the emergence of new forms of mobility, including e-bikes, e-scooters, and even personal aerial transportation.

Similarly, in certain regions, the sales of EVs have been affected by a combination of persistent economic difficulties and more resistant consumers. As a sector that accounts for over 15% of global energy-related emissions, it is crucial for electrification of the mobility sector to succeed for future sustainability.[2]

For mobility OEMs to increase market electrification, there is the challenge to innovate while reducing costs, in order to reach more consumers. While increasing efficiency of the electric drivetrain and charging systems are an obvious area of development, safety is also another. With both peoples' lives and the roads themselves becoming busier, more users are seeking out vehicles with heightened intelligence, autonomy and safety.

Consequently, as the field of electric mobility continues to evolve, prioritizing safety and implementing efficient charging solutions are two key areas that mobility markets must focus on to advance. Within this whitepaper we will explore how Murata's cutting-edge technology, encompassing passive electronics, sensors, and power components, are working to advance mobility designs advancement in these crucial areas, helping mobility OEMs to succeed.

1 https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-cars
2 https://www.iea.org/energy-system/transport/electric-vehicles

2. Understanding the Market Landscape: Push for Electrification and Enhanced Safety

The main impetus behind electric vehicles (EVs) lies in the global sustainability efforts and the shift away from polluting internal combustion engines (ICEs). However, there are additional factors at play in the market that must be addressed to encourage consumer adoption.

2.1 Environmental Regulation and Driving Adoption

Governments across the globe are implementing both incentives and regulatory reforms to promote the adoption of EVs, while simultaneously discouraging the sales of ICE powered vehicles. Numerous countries as well as the European Union (EU) have announced a ban on ICE cars, with Norway leading the way banning the sale of new petrol and diesel-powered vehicles from 2025. The UK has implemented mandates that require the sale of zero emission vehicles (ZEVs) and set yearly targets. Currently, the target for new cars in 2024 is 22% and for new vans it is 10%. These targets are leading up to a complete ban on internal combustion engine (ICE) cars and vans in 2035.[3]

While bans imposed by governments require automotive OEMs to transition their model lineups from traditional powertrains to cleaner electric alternatives, they are not the only methods employed to drive more sustainable mobility. To encourage the adoption of EVs and overcome consumer financial barriers, many governments have also implemented various financial incentives. For example, in the US, buyers can take advantage of a federal tax credit of up to $7,500[4], while other countries in Europe have also offered similar incentives.

EV charging infrastructure is also subject to regulation to ensure it can support growing vehicle sales. Starting in 2025 all EU member states must install a fast-charging station of at least 150 kW along every 60 kilometers of the trans-European transport network (TEN-T).[5] It is also mandatory for member states to offer a charging capacity of no less than 1.3 kW for every battery-electric vehicle registered within their jurisdiction, and 0.50 kW for plug-in hybrid vehicles.[6]

The role of policy support in promoting EV adoption cannot be understated, and this is particularly noticeable in China. China has implemented a range of tax incentives, regulations, and infrastructure development measures to bolster its growing EV market and encourage the adoption and manufacturing of electric mobility. The result is that out of the 40 million EVs sold in 2023, 14.1 million were sold in China alone.[7]

3 https://commonslibrary.parliament.uk/research-briefings/cbp-7480/
4 https://www.energy.gov/save/electric-vehicles
5 https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-charging
6 https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-charging
7 https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-cars

2.2 Consumer Demands and Removing Obstacles to Adoption

To promote electric mobility successfully, it is essential to have a deep understanding of the consumers' needs and preferences. Through targeted improvements in product designs and charging infrastructure, it will be possible to elevate existing solutions and create a diverse range of electric solutions that better cater to modern society.

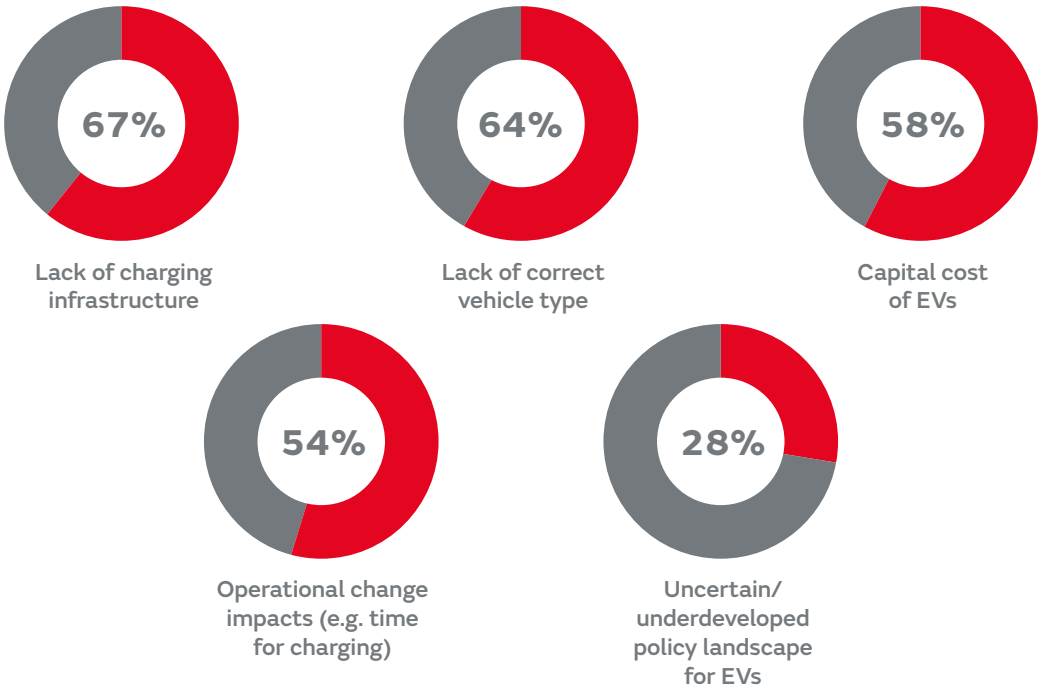
EV100 is a worldwide initiative aimed at assisting companies in transitioning their owned and contracted fleets to electric vehicles by 2030. According to the 2021 member's Progress and Insight Report, a significant obstacle to the adoption of electric vehicles was identified by 67% of respondents as the insufficient charging infrastructure, with a further 54% stating recharging times as another significant issue.[8]

While this is a glimpse into the commercial world, the consumer market is sending the same message, with supporting infrastructure often stated as a primary barrier for EV adoption. The UK's Transport and Environment revealed that public charging availability was a top concern for 16% of individuals, with an additional 20% expressing concerns about this issue.[9] Vehicle costs and charging times were also amongst the top five concerns, further driving the need for innovation that can reduce expenditure and cut charging times.

Similar themes appeared for micromobility solutions with AutoTrader Group finding that 50% of its respondents to one of its surveys reporting that high upfront costs were preventing adoption.[10]

For the industry to increase the rate of commercial and consumer EV and electric micromobility adoption, costs must drop, performance needs to increase, and infrastructure coverage needs to grow.

Top 5 Barriers to EV adoption



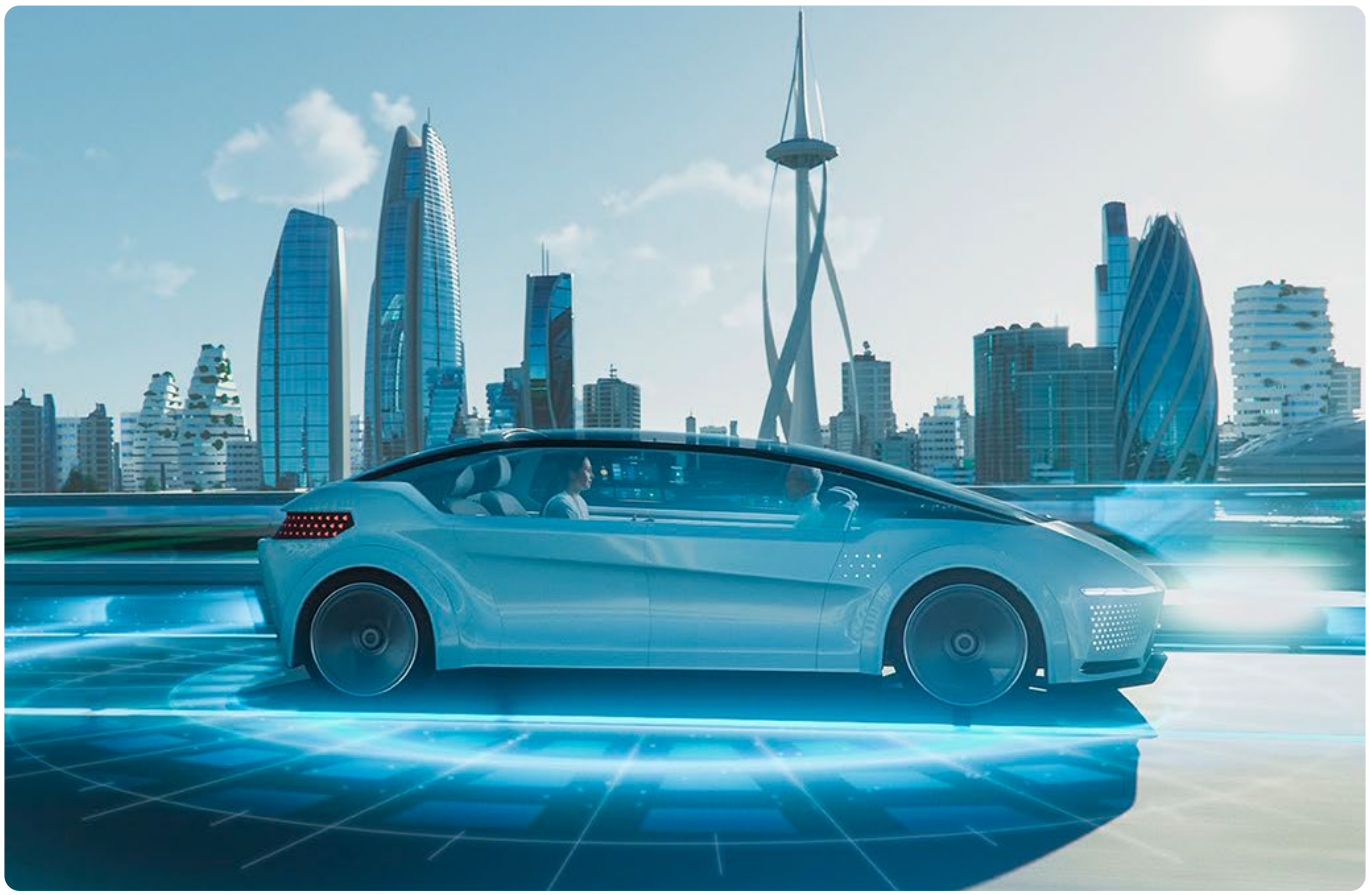
8 https://www.theclimategroup.org/ev100-annual-report-2021
9 https://www.transportenvironment.org/articles/barriers-to-next-phase-of-electric-vehicle-transition-revealed
10 https://plc.autotrader.co.uk/news-views/press-releases/nearly-half-of-car-owners-believe-e-bikes-could-replace-shorter-car-journeys/

Demanding Safety

With the push for vehicle electrification has also come a simultaneous industry drive for heightened advanced driver assistance systems (ADAS) functions, as well as a future push for autonomous driving. The electric and digital nature of EVs lends themselves well to by-wire operation, foregoing mechanical parts in throttle, steering and eventually braking systems. This advancement better facilitates enhanced ADAS capabilities and autonomous driving, enabling direct control through the vehicle's control electronics. Progress in microcontroller units, AI, and crucial sensors like image, MEMS, LiDAR, and ToF have also contributed to this development, allowing for more precise and intelligent operation at a lower vehicle price point.

While vehicle safety may not be the primary concern for many consumers, it remains a crucial aspect to consider, and developing safer transportation options is a shared objective that all stakeholders and consumers can support. According to a survey by YouGov, a significant 77% of respondents expressed their desire for all available safety features to be fitted to their car.[11]

Understanding the consumer's demand for safety can be complex, as it doesn't always align with industry trends. While autonomous vehicles are a key area of development for many automotive OEMs at present, many consumers are still skeptical and instead prioritize more advanced ADAS functions such as reversing cameras, blind spot detection, and automatic emergency braking (AEB). In a survey from S&P Global, full self-driving autonomy was found to be the least desired vehicle safety function ranking behind sub-autonomous functions such as highway automated driving and remote parking.[12]



11 https://business.yougov.com/content/43657-global-how-important-safety-survey
12 https://www.spglobal.com/mobility/en/research-analysis/consumers-desire-automated-safety-over-selfdriving-tech.html

Regulation Driving Safety

Effective from July 2022 for new models and from July 2024 for existing models, the EU's updated General Safety Regulation requires the implementation of various advanced safety features.[13] These include Autonomous Emergency Braking (AEB) and Intelligent Speed Assistance (ISA). Similar regulation in the US, Japan and China are driving uptake of these critical safety elements.

Micromobility Safety

Safety is also being enhanced in micromobility solutions. ABS and GPS navigation systems have made their way from cars to motorcycles and now into e-bikes, enhancing user safety and adding to their overall enjoyment.

The micromobility rental market is implementing advanced technology to enable the implementation of dynamic speed limits on rental e-bikes and e-scooters. Stockholm's rental scooters are equipped with GPS-enabled speed limits that adjust according to the location. When entering a pedestrianized area, the speed limit of the rental e-scooter is reduced to 6 kph. Upon returning to a bicycle lane or road, the speed limit increases.[14]

3. Evolving ADAS and Autonomous Vehicle Technologies

ADAS, once a distant acronym associated with technologies removed from consumers' purchasing decisions, has now evolved to include a diverse range of functions that are essential selling points for modern vehicles. The advancements in automotive intelligence have led to the development of various functionalities that can enhance vehicle safety for both occupants and pedestrians, as well as alleviating the challenges of driving.

The latest mobility designs incorporate a wide range of internal and external safety functions specifically designed to enhance safety and work in conjunction with other safety features to ensure overall safety improvement.

Several of these features are advancements of previous safety components. For example, ACC is a more advanced version of regular cruise control, utilizing advanced processing and additional sensor fusion to provide enhanced functionality. Autonomous operation takes this principle further, combining entire safety systems to allow a vehicle to perform tasks without human intervention.

The progression from basic ADAS to fully autonomous vehicles encompasses multiple stages of technological advancement, commonly classified into five levels by the Society of Automotive Engineers (SAE):

- **Level 0 (No Automation):** The driver has complete responsibility for operating the vehicle.
- **Level 1 (Driver Assistance):** This includes individual automated systems like cruise control or lane assistance.
- **Level 2 (Partial Automation):** Combines at least two ADAS functions, like ACC and LKA, but the driver must remain engaged.
- **Level 3 (Conditional Automation):** The vehicle can handle driving in specific conditions, but the driver must be prepared to take over when necessary.
- **Level 4 (High Automation):** The vehicle can autonomously handle most driving tasks without the need for driver intervention, but the driver can take over if necessary.
- **Level 5 (Full Automation):** The vehicle can handle all driving tasks in any condition without human involvement.

13 https://www.atic-ts.com/european-automotive-aebs-system/
14 https://miljobarometern.stockholm.se/content/docs/tema/trafik/elsparkcykel/Data%20driven%20regulation%20of%20micromoblity.pdf

At present, many OEMs offer Level 2 vehicles, with Mercedes and BMW being the only manufacturers to offer a Level 3 vehicle across Europe. Under specific circumstances, including clear weather, daytime, speeds below 40 miles per hour, and congested traffic, Mercedes's Drive Pilot technology equipped to 2024 EQS sedans and S-Class models enables drivers to disengage from steering and visual attention,[15] while BMW have become the first manufacturer worldwide to receive approval for a combined Level 2 and Level 3 driving assistance system. These functionalities will be combined in the new BMW 7 Series, offering greater comfort on short and long motorway journeys[16]. It is expected that Level 4 vehicles will be accessible in the next ten years, but in the meantime, ADAS functionality and other safety systems in vehicles are constantly improving to enhance safety and user satisfaction.

Vehicle Safety Function	Functionality	Sensors
Adaptive Cruise Control (ACC)	Automatically adjusts the vehicle speed to maintain a safe distance from vehicles ahead	Radar sensors, LiDAR sensors, image sensors, MEMS sensors
Lane Departure Warning (LDW) Lane Keeping Assist (LKA)	Alerts divers when they unintentionally drift out of their lane and assists in steering the vehicle back into the lane	Image sensors, radar sensors, LiDAR sensors, MEMS sensors
Blind Spot Detection (BSD)	Monitors and alerts drivers to vehicles in their blind apots	Radar sensors, ultrasonic sensors, LiDAR sensors
Traffic Sign Recognition (TSR)	Identifies and displays traffic signs on the vehicle's dashboard, aiding navigation and speed limit adherence	Image sensors
Parking Assistance	Provides steering assistance during parking, and in some cases, fully automates the parking process	Ultrasonic sensors, LiDAR sensors, Radar sensors, image sensors
Occupancy Monotoring	Monitors seat occupancy, ensuring other safety features are correctly deployed and passengers are not left in the vehicle	Image sensors, ToF sensors, LiDAR sensors
Electronic Stability Control (ESC)	ESC helps prevent loss of vehicle control by automatically applying brakers to individual wheels	MEMS sensors, rotational speed sensors
Automatic Emergency Braking (AEB)	Detects potencial collisions and applies brakes automatically to prevent or mitigate accidents	LiDAR sensors, radar sensors, image sensors

Figure 1 – Example ADAS functions and their supporting technologies (Source: Murata)

15 https://www.mercedes-benz.co.uk/passengercars/technology/autonomous-driving.html
16 https://www.press.bmwgroup.com/global/article/detail/T0443285EN/road-to-autonomous-driving:-bmw-is-the-first-car-manufacturer-to-receive-approval-for-the-combination-of-level-2-and-level-3?language=en

3.1 Murata's Mobility Safety Solutions

In order to support the evolving requirements of mobility safety, manufacturers require solutions which can help increase functionality without adding excess costs, weight or system complexity. Murata has been a key player in the automotive and emerging mobility market, and as we transition into the electrified era, the importance of its solutions will only grow. It has a wide range of tailored products that are designed to help OEMs enhance the safety and intelligence of their solutions as we enter into the next generation of transportation.

Automotive MEMS

Perception is key for intelligent operation - whether it is an autonomous vehicle winding through country roads or a rental e-scooter obeying speed limits and restricted zones, accurate perception is essential for safe operation. Murata is widely recognized for their expertise in MEMS gyroscope and accelerometer devices, and its previous generation 6 degrees-of-freedom (6DoF) MEMS solution has already demonstrated remarkable success, enabling over 90% of all autonomous vehicle miles driven in California.

The new SCH1633-D01 builds on this success and is tailored to meet the demands of the latest automotive and mobility systems. It moves the benchmark for performance, affordability, and system integration for a range of automotive and mobility applications, including autonomous driving, ADAS, automotive and micromobility inertial measurement units (IMUs), and sensor or headlight alignment systems.

In advanced ADAS functions and the forthcoming generation of autonomous vehicles, it provides heightened accuracy that exceeds existing solutions, enabling precise vehicle decision-making and navigation. Likewise, it permits compliance with technical regulations such as the UNECE's headlight leveling regulation, by supplying positioning feedback that can be employed to develop headlight designs that are both more accurate and safer.

The product leverages Murata's updated 3D MEMS technology and is perfect for zonal architecture, supporting centralized IMU designs. Its SafeSPI 2.0 interface, boasting a 20-bit data frame, data ready timestamp index, and SYNC functions, enables various subsystems such as GNSS integration, chassis control, and vehicle attitude sensing (camera and headlight alignment) to make use of its measurements.

United Nations Economic Commission for Europe Headlight Regulations

The UNECE's headlight regulation defines stringent requirements for vehicle lighting, especially for adaptive driving beam (ADB) systems. These systems are designed to automatically adapt the headlight beam to prevent glare for drivers approaching from the opposite direction, while still providing optimal visibility for the driver. The regulation improves road safety by reducing accidents caused by glare and enhancing visibility through clear performance requirements for ADB technology and harmonized headlight specifications across countries but is reliant on high-performance position sensors, like Murata's SCH1633-D01 to ensure headlights are kept level.

Enhancing In-Cabin Safety

As self-driving technology becomes more widespread, it is of utmost importance for vehicles to possess an understanding not only of their external environment but also the interior of the vehicle. This comprehensive awareness allows for the optimal deployment of safety systems as well as monitoring passenger awareness for situations where controls must be passed back to the driver.

Murata's Type 1VM is a mmWave Radar sensor module that excels at accurately measuring distance, angle of arrival, and velocity of target objects, even in challenging environments. The 60 GHz in-cabin radar module detects a living presence inside a vehicle, determines if an occupant is an adult or child, and shows their respective seat position. 60 GHz technology features a physical short (approx. 5mm) wavelength, helping to reduce the modules' overall size, reduce interference with other systems and increase detection accuracy.

By emitting a signal that is continuously modulated in frequency, the radar module is able to detect the reflected signal and ascertain whether there is any movement in the vehicle. This feature enables the radar to identify the presence of a person based on the delicate movements caused by their breathing. The central processing unit (CPU) within the module performs calculations utilizing data from three transmitters and four receivers, enabling vehicles to obtain information on presence detection, passenger location, and passenger classification (differentiating between adults and children). Beyond child presence detection (CPD), Murata's mmWave system can allow for the intelligent deployment of airbags, seatbelt reminder systems and smart gesture detection, as well as passenger detection for robot taxis applications.

Ultrasonic Sensors

Ultrasonic sensors are a key perception element for modern vehicles. Utilized in parking and lane departure systems as well as autonomous driving systems, they enable proximity detection of objects around a vehicle. Besides being employed in passenger vehicles, they are also deployed in alternative modes of mobility, such as autonomous delivery robots and industrial vehicles, with the primary goal of safeguarding people within their vicinity.

Murata's drip-proof ultrasonic sensors are fabricated through the process of adhering piezoelectric ceramics to a metal casing, followed by the injection of resin into the casing opening. This design provides protection against the intrusion of water droplets and dust, which can pose challenges when the product is used in outdoor environments.

The advanced ceramic production process used for the sensors has been refined by Murata over many years and effectively reduces both the resonance frequency and capacitance tolerance to 50% of conventional products. This helps to improve the stability and detection performance, enabling accurate short and long-distance detection and helping to increase the perception of intelligent mobility designs.
The increased range of detection enables the sensors to be compatible with both current ultrasonic.

Reducing Child Fatalities

It is an unfortunate truth that children can become trapped in vehicles, resulting in an average of 39 child fatalities per year in the US alone.[17] Whether this is accidental, intentional, or the child has entered the vehicle without the knowledge of the owner and become trapped, in all situations, the risk to the child's safety remains. Murata's direct sensing solution enables accurate monitoring of a child's presence, even if the child is out of position, sleeping or covered by a blanket. This technology allows manufacturers to meet Euro NCAP Child Presence Detection scoring by preserving passenger privacy, unlike image sensor solutions. In the event of a child being detected within a locked vehicle Murata's system can allow OEMs to implement powerful inventions such as sounding the alarm, lowering windows or switching on the air conditioning, helping to prevent unnecessary fatalities.

3.2 Increasing Sensor Integration

Increasing vehicle perception and therefore safety comes at a cost. Away from the component and development investment, one of the biggest challenges is integrating the technology into already space constrained automotive designs. While component miniaturization, a key focus of Murata, is critical in overcoming this challenge, sometimes additional measures are required to cut system volume. With image sensors being a vital component in countless ADAS functions, the number of cameras deployed within vehicles continues to increase, and with it an increase in cabling. Numerous mobility manufacturers, including OEMs and Tier 1 suppliers, are actively embracing power over coaxial (PoC) technology to minimize the amount of cables needed for automotive cameras. This technology integrates both signal lines and power supply lines.

In order to introduce PoC, it is crucial to incorporate a 'Bias-T circuit' on the transmitting and receiving ends, as well as on the power supply.

17 https://www.carlsonattorneys.com/news-and-update/forgotten-baby-syndrome

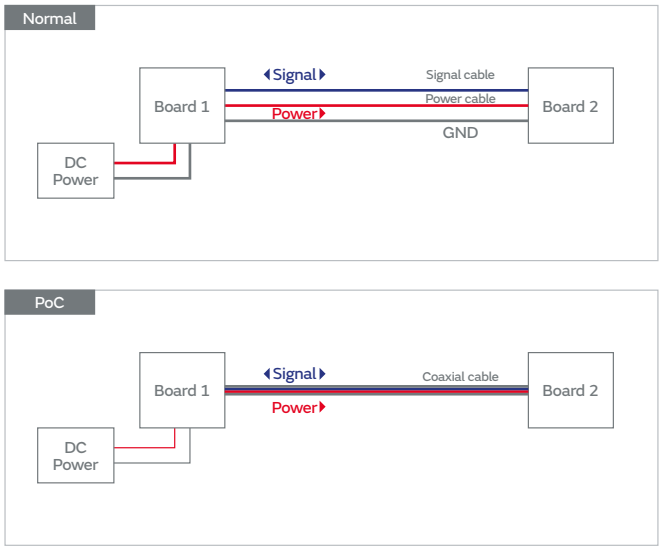


Figure 2 - The Bias-T circuit isolates the power supply line and the signal line (Source: Murata)

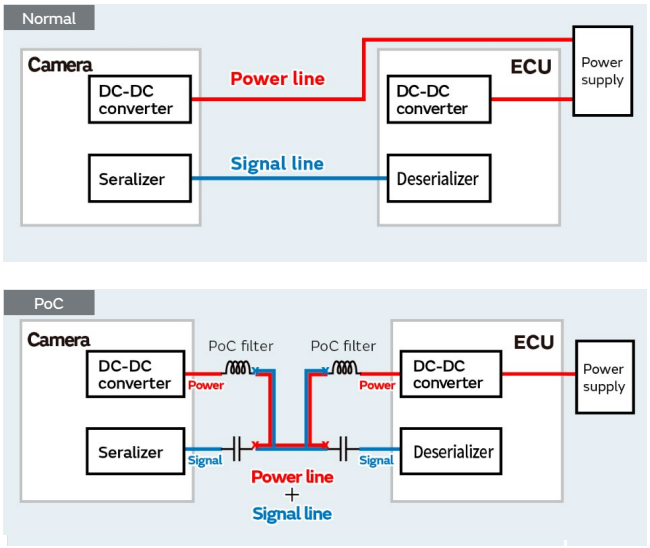


Figure 3 - A comparison between a conventional setup and the PoC method, complete with Bias-T filter circuits (Source: Murata)

PoC is a system that superimposes a power supply and signals onto one coaxial cable to help reduce the number of cables.

The purpose of a Bias-T circuit is to separate the high-frequency signal from the DC power supply on the low-frequency side. The circuit includes an inductor for filtering high-frequency video signals and a capacitor for filtering the DC power supply.

But selecting the optimal combination of inductor products from a wide variety can be a challenging and time-consuming process. To streamline development and support highly integrated PoC designs, Murata has created the **Bias-T Inductor Selection Tool (BIST).**

Through the configuration of the minimum number of conditions, the tool is able to identify and present the optimal combination of Murata's high-performance and compact inductors and ferrite beads. BIST greatly cuts down on the effort and time required to select components, making it possible to choose suitable ones even without specialized knowledge.

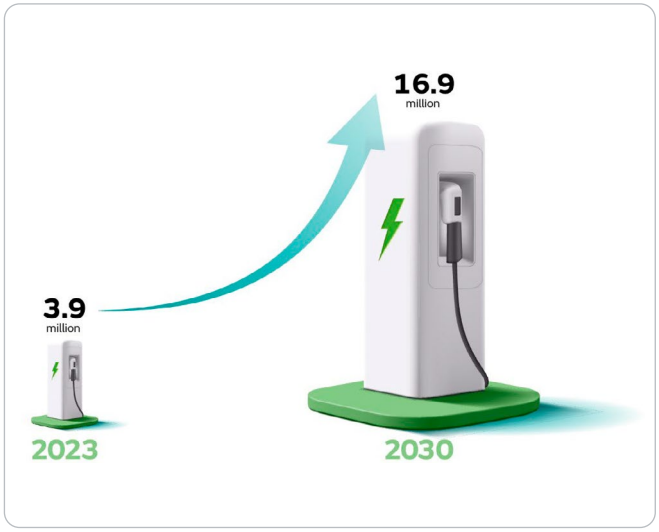
Supporting High-Speed In-Vehicle Networks (IVNs)

To bring about the next generation of intelligent mobility safety systems, manufacturers must utilize reliable ethernet-based zonal architectures that are fast and efficient. Murata provides a diverse selection of products that meet the standards for high-speed CAN/CAN-FD and vehicle-mounted Ethernet, as well as other vehicle-mounted networks. These products come in a compact size and offer exceptional noise suppression. Murata was amongst the first manufacturers to introduce miniaturized 3225 (3.2 mm × 2.5 mm) size common mode choke coils (CMCCs). Its mobility specific range includes the **DLW32SH510XF2** or **DLW32SH101XF2** which is designed specifically for CAN-FD signal lines or the **DLW32MH101XT2** which is designed for 1000Base-T1 (1000Mbps) ethernet.

4. Charging Technologies for Electric Mobility

As the adoption of EVs continues to accelerate, the need for robust charging infrastructure increases. Beyond the initial group of early adopters, consumers are becoming less compromising and have higher expectations for faster charging. Equally, as the number of electric vehicles on the roads continues to rise, a larger quantity of charging stations is needed, and these stations must operate at a higher performance level to enable quicker vehicle passage. Therefore, innovation of the charging station is key for the electric mobility market's ongoing success.

In 2023, the global infrastructure saw a significant growth to reach 3.9 million charging stations, and an additional 1.2 million stations were added.[18] However, in order to meet the rising sales of electric vehicles and align with the goals of the Paris Agreement to achieve global Net Zero by 2050, the global EV charging network must expand to 16.9 million stations by 2030.[19]



Several difficulties confront existing charging infrastructure, including limited availability, extended charging durations, and inconsistent standards in different regions. These obstacles pose significant challenges to the widespread acceptance of electric vehicles, as drivers need easy, quick, and dependable access to charging stations to meet their transportation requirements.

One study conducted in the United States revealed that 25% of EV owners surveyed encountered significant obstacles to adopting electric vehicles, with nonfunctional or broken charging stations being a common issue, often caused by network communication problems.[20] While in the United Kingdom, the percentage of fast or ultra-fast chargers is only 20%, which falls short of both consumer and commercial expectations.[21]

Efficient and reliable charging solutions are a necessity for the successful integration of electric vehicles into mainstream transportation.

Addressing existing challenges involves deploying advanced charging technologies, including ultra-fast chargers, wireless charging systems, and smart grid integration, all of which can enhance user convenience, reduce charging time, and ensure energy efficiency. These innovations play a crucial role in surmounting present obstacles and cultivating consumer trust in electric mobility, thereby propelling the shift towards a sustainable and electrified transportation future.

4.1 Murata's Charging Solutions

As a leading global electronics manufacturer, Murata has a wide range of solutions designed to elevate charging station designs. Murata's products are designed to help manufacturers create higher performing solutions at lower prices, propagating the growth of fast charging networks. From capacitors to conductivity modules, Murata's solutions are extensively tested, trusted and inherently robust, meaning designers of EV charging solutions can be confident in their product's reliability for years to come.

18 https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer
19 https://www.iea.org/reports/global-ev-outlook-2023/trends-in-charging-infrastructure
20 https://arxiv.org/ftp/arxiv/papers/2203/2203.16372.pdf
21 https://www.zap-map.com/ev-stats/how-many-charging-points

Isolated DC-DC Converter for Gate Drivers

Murata's range of **DC-DC converters for gate drive** provide the necessary characteristics and performance required by modern EV charging infrastructure, including high isolation and dv/dt requirements. Designed for powering 'high side' and 'low side' gate drive circuits typically used in inverters, a choice of output voltages are available, optimized for MOS, IGBT, SiC & GaN gate drives allowing for optimum drive levels and best system efficiency.

The MG* series feature continuous barrier withstand voltages ranging from 1.1kVDC to 3kVDC and output powers between 1W to 6W. All modules feature industrial grade temperature rating, robust EMI performance and construction, helping to ensure future EV and smaller mobility charging stations stay in operation.

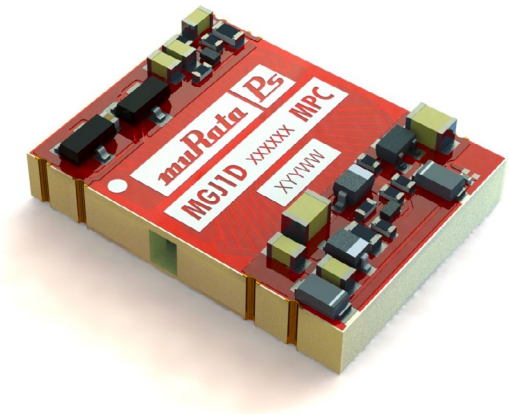


Figure 5 - Murata's MG series (Source: Murata)
NXJ1 series is also available.

Delivering Connected Intelligence

For charging stations and micromobility vehicle docks, connectivity plays a crucial role in ensuring the end-users experience is maintained. In the absence of reliable connectivity, faults in charging stations or rental mobility solutions go unnoticed, potentially leaving them in a state of disrepair. In addition, connectivity can offer users intelligent insights and seamless integration with their smartphones, providing quick access to charging levels and vehicle range.

Murata provides a comprehensive range of connectivity solutions designed to speed up development and deliver high-performance and reliable operation. The **Type 1SC** (LBAD00XX1SC) module is the world's smallest LTE Cat-M1/NB-IoT module with global certification. Both LTE Cat-M1 (LTE-M) and Narrowband IoT (NB-IoT) are LTE technologies standardized by 3GPP. They offer low-cost and low power operation, making them an excellent choice for IoT networks with disturbances, like smart EV chargers. OpenMCU is supported by the affordable module, and Murata has teamed up with Truphone to enable communication on MVNO networks using eSIM technology.

All of Murata's modules follow its ethos of miniaturization and efficiency, and feature incredibly low energy requirements in compact packaging. As well as Murata's long-range communication solutions, it provides support for the latest wireless protocols, including **short-range Wi-Fi 6 and Bluetooth modules** allowing for localized smart phone and vehicle-to-infrastructure (V2I) communication. With Murata's modules, engineers can be sure that any charging infrastructure remains connected and operational for years to come, as well as offering new intelligent functionality to the end-user.

Elevating Charging Infrastructure

The primary objective of EV charging infrastructure is to accommodate the increasing number of EVs on the road, but it is equally crucial to improve the intelligence, performance, and reliability of charging stations.

As global emissions continue to rise and concerns about oil supply security grow, the demand for EVs is expected to rise even more. However, consumers must not be discouraged by unreliable or insufficient charging stations. Innovative solutions for EV chargers, like the ones created by Murata, can enhance manufacturers' designs by offering faster and more efficient charging through high-performance transformers. They can also improve end-user and network utilization through the implementation of smart communication.

Likewise, these solutions can support other forms of transportation, such as robot taxis and delivery vehicles, by improving the performance of charging stations. Additionally, communication and GNSS modules can enhance the design of e-bikes and e-scooters, allowing integration with personal smart devices and enabling easy tracking of rental fleets.

5. Murata: Empowering Automotive Tier 1s and OEMs

Murata has established itself as a pivotal enabler for the automotive industry, forming strategic partnerships with leading Tier 1 suppliers and OEMs both large and small. Murata goes beyond product supply, delivering tailored solutions for the mobility market and providing extensive engineering support and custom solutions. This fosters the development and integration of advanced technologies that drive the evolution of modern mobility solutions. These collaborative efforts ensure that automotive companies can seamlessly incorporate innovative components and systems, enhancing the safety, efficiency, and overall performance of their products.

5.1 Market Leading MLCCs

Passive electronic components, like capacitors, play a vital role in automotive vehicles by supporting the numerous electronic circuits. They are used to stabilize the operation of semiconductor chips, and without these essential components, critical vehicle circuits cannot function as intended. With approximately a 40% market share, Murata is the leading global supplier of multilayer ceramic capacitor (MLCC) components (Figure 7).[22]

In the automotive industry, Murata's 50% market share of MLCCs reinforces its status as the leading supplier, highlighting the unwavering trust placed in Murata's technology by OEMs and Tier 1 manufacturers.[23]

At present, conventional vehicles typically use between 3,000 to 5,000 MLCCs, while autonomous equipped models require approximately 10,000 MLCCs. However, as the next generation of interconnected and intelligent vehicles emerges, the number of MLCCs will rise due to the integration of a greater number of systems.[24]

Figure 7 - Murata is renowned for its MLCC technology (Source: Murata)

22 https://corporate.murata.com/en-eu/company/business/capacitor
23 https://corporate.murata.com/en-eu/company/business/capacitor
24 https://article.murata.com/en-eu/article/automotive-mlcc-1

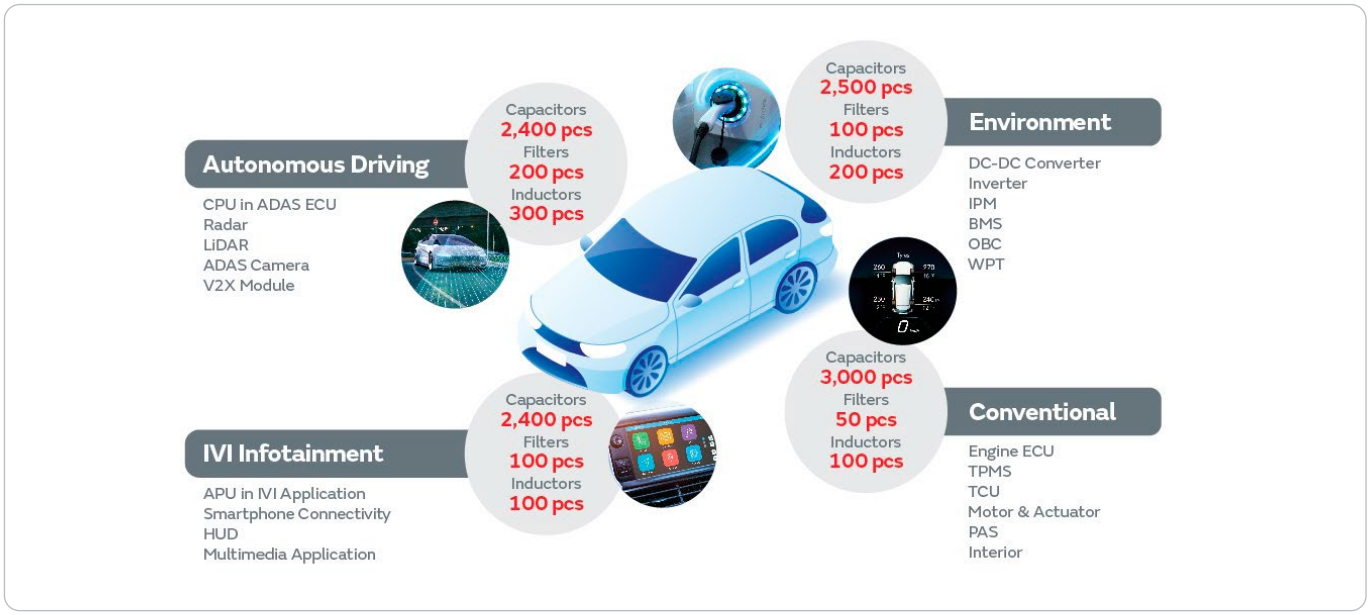


Figure 8 - Smarter vehicles demanding an increasing number of MLCCs (Source: Murata)

Automotive MLCCs are crucial components in machinery that directly impacts human safety, requiring the higher levels of quality and reliability compared to MLCCs found in consumer devices. Longevity is another key aspect with cars having a typical lifespan that is far beyond that of consumer electronics. Murata produces a wide range of automotive specific MLCCs that harness cutting-edge material and fabrication techniques to ensure they meet the rigors of automotive deployments.

This includes the new **LLC series.** These components are the world's first 0.18mm profile packaged MLCC to feature reversed termination, ensuring low equivalent series inductance (ESL). To ensure longevity, this range has been tested to comply with AEC-Q200 requirements, passing the rigorous 1000 temperature cycle test and enduring 85°C temperature and 80-85% humidity for 1000 hours. Furthermore, the footprint for 1µF capacitance is a mere 0.5 x 1.0mm, making these parts the smallest available in the market, helping to reduce board occupancy and capacitor count.

By employing advanced material atomization and homogenization techniques, along with Murata's proprietary thin-layer forming and high-precision lamination technology, the LLC series manages to reduce component height by approximately 20% when compared to existing parts. The placement of capacitors on the rear side of circuit boards, even in the presence of solder ball terminations, offers the advantage of optimal positioning for decoupling processor power rails near the die. As a result, fewer capacitors are needed, leading to cost savings and increased system reliability.

The capacitors' low ESL, combined with reduced equivalent series resistance (ESL), decreases high-frequency impedance, enhancing circuit performance to meet the demands of modern, low-voltage, compute-intensive applications like automotive ADAS.

Whether an MLCC is being used in ADAS functions, infotainment or power circuitry Murata will have a highly tailored and miniaturized solution that can elevate designs providing the required functionality while aiding in PCB space reduction.

Figure 9 – The miniaturized LLC range occupy minimal board space while providing maximum performance (Source: Murata)

5.2 Wide Range of Products

Murata's diverse product portfolio is tailored to meet the unique demands of the automotive sector. From sensors and communication modules to power supplies and capacitors, Murata's offerings are designed to address the challenges of today's automotive landscape. What sets Murata apart is commitment to innovation, providing products that offer superior reliability,

miniaturization, and energy efficiency-critical factors in the design of next-generation mobility solutions.

As well as the products covered here, Murata also provides a wide range of market leading passive electronics. This includes **NTC thermistors** designed to fulfill the requirements of mobility subsystems such as inverters and charging systems, as well as Murata's cutting-edge **crystal timing units.**

Key to maintaining the timing of operations at the heart of autonomous and ADAS functions these units' unique construction that enables greater manufacturing simplicity, higher production output and lower cost.

Figure 10 - Murata's crystal timing devices use a unique construction method that lowers costs and increases production yield (Source: Murata)

5.3 Robust Manufacturing and Quality Assurance

At the heart of Murata's success is its world-class manufacturing capability, which is built on decades of expertise and a relentless pursuit of excellence. Throughout its operations, Murata employs cutting-edge technologies and rigorous processes to ensure that every product meets the highest standards of quality and reliability. Murata's unwavering dedication to quality is mirrored by its strong commitment to sustainability. In its pursuit of supporting the mobility market's goal of achieving carbon neutrality, Murata offers a wide selection of highly efficient products.

Engineer Support and Application Knowledge

Murata's team of skilled engineers is readily available to assist with the integration of its products, offering in-depth application knowledge and tailored solutions. Furthermore, Murata provides a comprehensive range of resources and services that empower automotive engineers, giving them the necessary tools and expertise to overcome technical challenges and attain their design objectives.

Murata and Sustainability

In December 2020, Murata became a member of RE100, an initiative that strives to transition business operations to 100% renewable electricity by the year 2050. Kanazu Murata Manufacturing has become the inaugural facility within Murata to achieve "100% renewable energy" and features an innovative carport equipped with 383kW solar panels on its roof.[25]

6. Conclusion: Driving Mobility into the Future

Ongoing contributions to electric mobility and vehicle safety have established Murata as a key enabler across the entire mobility spectrum, from traditional automotive to emerging micromobility solutions. Its innovative technologies are driving advancements in EVs and supporting charging infrastructure, as well as enhancing the safety, efficiency, and sustainability of emerging forms of transportation. As the mobility landscape continues to evolve, it is critical for OEMs to utilize targeted solutions that can help to elevate performance, safety and reliability in a way that resonates with the market and the evolving landscape of transportation.

Murata is dedicated to equipping its partners with the tools and knowledge they need to shape the future of transportation, whether it's through electric cars, bikes, scooters, or other means of travel. For further information, please visit Murata's website or contact your local Murata representative.

25 https://article.murata.com/en-eu/article/sdgs-responses-to-climate-change-kanazu-1

More Information

Please visit the websites below

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