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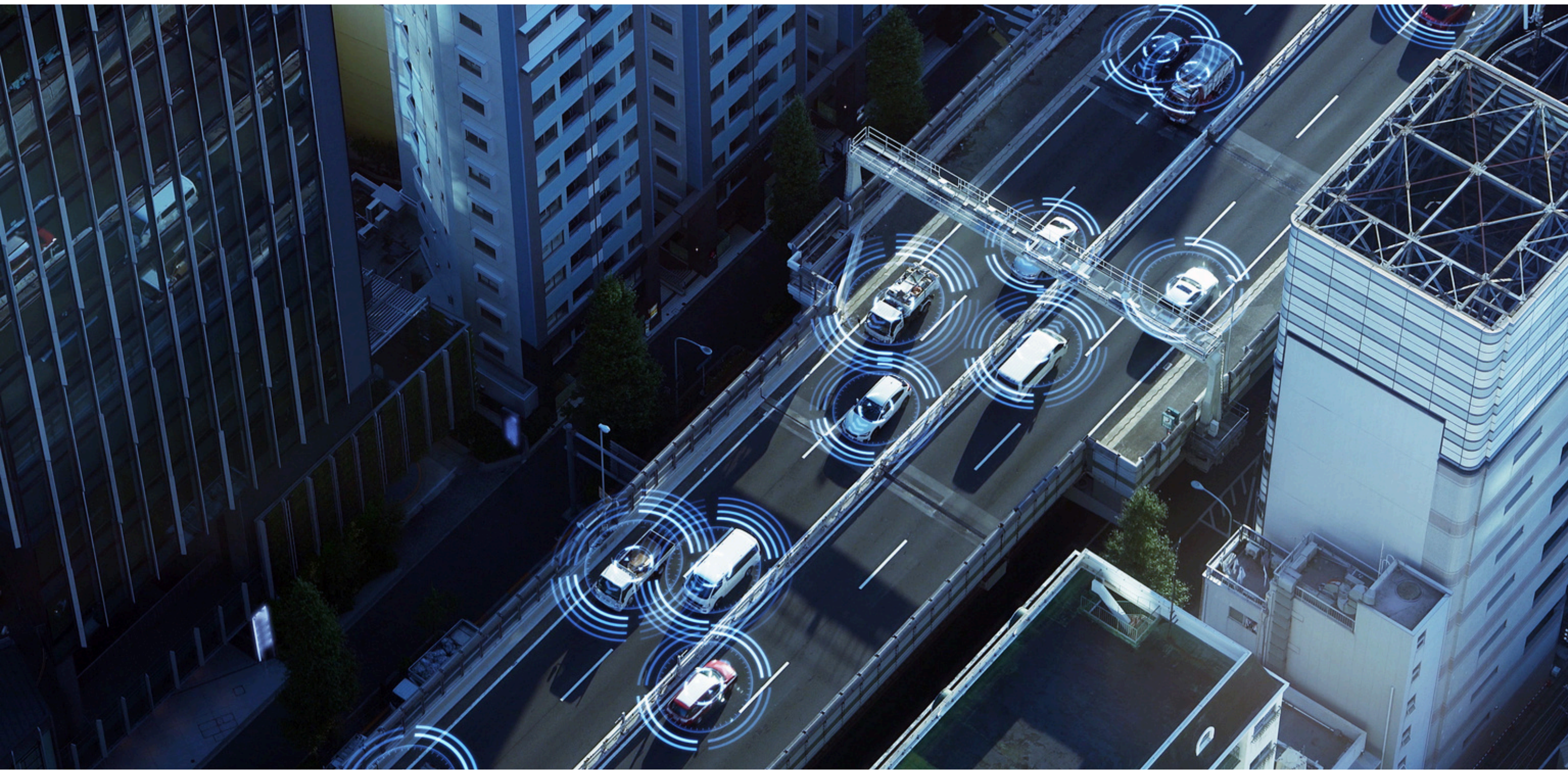
Enabling the Future of Autonomous Driving with Advanced Electronic Components



The automotive industry is shifting from driver assistance to higher levels of autonomy. The global autonomous vehicle market size is estimated at USD 273.75 billion in 2025 and is forecasted to reach around USD 4,450.34 billion by 2034, growing at a compound annual growth rate (CAGR) of 36.3% from 2025 to 2034. [1]

This transition depends not only on advanced software but also on precision-engineered electronic components that enable vehicles to sense their environment, process information, and respond in real time. Reliable sensing, high-speed communication, and efficient power electronics are central to autonomous driving systems.

This article discusses the role of advanced electronic components in enabling autonomous driving and highlights how Murata, [2] a global leader in advanced electronic components, supports this transformation with reliable, high-performance solutions tailored for automotive applications.

Integrated Solutions Across the Autonomous Stack

Autonomous driving systems rely on an ecosystem of tightly integrated electronics that enable perception, decision-making, and connectivity in real time. Murata supports this ecosystem through a broad portfolio of sensors, passive components, and communication modules designed for automotive use. The strength of Murata's approach lies in the performance of individual components and in their ability to function together across the full autonomous driving stack.

Central Compute ECU Trends

A key trend for autonomous platforms is the consolidation of multiple electronic control units (ECUs) into central compute architectures. Instead of dozens of distributed ECUs, automakers are moving toward fewer, more powerful central compute units capable of handling complex perception, planning, and control functions. These architectures demand high-performance SoCs with significant processing and power requirements. Murata contributes in this regard by providing components such as high-reliability silicon capacitors, inductors, and communication modules that ensure stable operation, signal integrity, and efficient power delivery within these high-power compute domains.

Sensors for Perception and Control

Murata offers a range of sensors that feed critical data into autonomous platforms, supporting the performance of central SoCs. These include accelerometers, gyroscopes, pressure sensors, and inertial measurement units (IMUs) optimized for stability and precision under demanding automotive conditions. IMUs are particularly important for high-precision vehicle localization, complementing GPS and enabling accurate navigation even in tunnels, urban canyons, or environments with weak satellite signals. Murata's IMU solutions enhance the reliability of autonomous driving functions by providing precise motion and orientation data, and contribute to seamless sensor fusion with radar, LiDAR, and camera inputs.

Passive Components for Signal Integrity and Power Stability

Passive components play a less visible but equally crucial role in the performance of autonomous systems. Murata's ATSC silicon capacitor series combines compact footprints with stable operation in harsh environments. The series offers capacitance values ranging from 390 picofarads to 1 microfarad in package sizes as small as 0.63 × 0.63 mm, supporting space-constrained automotive electronics. These capacitors operate reliably across a temperature range of −55 °C to +200 °C, with negligible ageing effects of less than 0.001% per 1,000 hours, making them suitable for ADAS circuits exposed to continuous thermal cycling. [3, 4]

The ATSC capacitors provide secure operation in automotive power domains with a rated voltage of 16 VDC and a breakdown voltage of 30 VDC. Their capacitance variation is limited to about 0.1% per volt, and insulation resistance reaches up to 50 GΩ at 10 V and 25 °C, ensuring minimal leakage and consistent decoupling performance. This high reliability is reflected in a reported failure rate below 0.017 FIT (failures in 10^9 device hours), supporting the stringent lifetime expectations of safety-critical automotive platforms. [3, 4] Similarly, the **WASC series** supports wide operating voltage ranges with stable performance, making them suitable for the power management and high-frequency filtering demands of autonomous platforms. These passive components enable consistent system responses even under rapidly changing conditions on the road. [5]

Communication Modules for Connectivity

Murata's wireless communication modules cover Wi-Fi, Bluetooth, and cellular interfaces that are widely adopted in telematics and infotainment units. For in-vehicle networking, Murata provides modules that support Ethernet and CAN-based architectures, aligning with OEM shifts toward zonal and central compute platforms. These modules are designed to meet automotive-grade standards for temperature tolerance, vibration resistance, and long lifecycle performance.

Integration and Reliability Across the Stack

Murata enables system designers to reduce complexity, minimize footprint, and maintain the high reliability required for safety-critical applications by offering components that are optimized to work together. Automotive-grade compliance across product families ensures that these solutions can withstand the operational stresses of real-world driving and support the scalability needed for higher levels of autonomy.

Powering Automotive LiDAR: The Role of Silicon Capacitors

LiDAR systems are critical for autonomous vehicles to perceive their surroundings by emitting laser pulses and detecting their reflections to create high-resolution 3D maps. This application requires capacitors capable of supporting high-output, short-pulse light emissions, which translate into precise distance and object detection.

Murata's silicon capacitors and integrated passive devices (IPDs) are specially developed to meet these LiDAR requirements. Their low equivalent series inductance (ESL) characteristics enhance detection range and resolution. Due to their small size and low profile, these capacitors are placed very close to laser diodes and connected via wire bonding, reducing parasitic inductance and enabling emission of narrow pulses approximately 1.5 nanoseconds wide at power levels of 100 watts or higher. Silicon IPDs further enhance this capability by integrating capacitors and wiring within a silicon interposer, achieving even shorter pulses of about 0.9 nanoseconds at 120 watts or more. These technological advantages allow LiDAR systems to deliver high output safely within eye-safe standards (IEC 60825), supporting advanced autonomous driving functionalities in compact device footprints. [6]

Ultrasonic Sensing for Near-Field Object Detection

Just like technologies like LiDAR are used for long-range perception, autonomous vehicles rely on ultrasonic sensors for close-range object detection, which is critical for parking assistance, low-speed maneuvers, and near-field safety. Murata's latest drip-proof ultrasonic sensor, the MA48CF15-7N, demonstrates the company's innovation in this space. It is housed in a hermetically sealed package to prevent liquid ingress and remain functional in wet conditions such as rain or surface spray. The sensor operates by emitting ultrasonic waves and measuring their reflections for both object presence detection and distance measurement applications. [7]

It operates over a wide detection range from 15 cm to 550 cm and covers a beam angle of 120° by 60°, enabling accurate and wide-area obstacle detection. Such a range and coverage allow vehicles to identify obstacles in complex environments like parking lots or urban traffic scenarios. [7]

Its capacitance of 1100pF±10% at 1kHz is tightly controlled, removing the need for transformer adjustments. The sensor also achieves a resonant frequency of 48.2±1.0kHz and a Q value of 35±10, with tolerances reduced by half compared to previous versions. These refinements result in more consistent detection characteristics across individual units and improved performance over varying temperatures. [7]

In the context of ADAS and Level 2+ autonomous functions, ultrasonic sensors like the MA48CF15-7N complement other perception technologies such as radar and cameras. [7]

Design and Reliability Considerations for Automotive-Grade Electronics

Automotive environments subject electronic components to demanding conditions. In this regard, compactness is a fundamental requirement, since modern vehicles integrate a number of sensors, communication modules, and control units in limited spaces. Therefore, maintaining a small footprint ensures that they fit within dense electronic control systems.
Heat resistance is also very important as power electronics, sensor modules, and communication systems are often located near engines or high-current pathways, where ambient temperatures fluctuate widely and may remain elevated for extended periods. Components used in such settings must retain stable electrical characteristics across these conditions to avoid degradation over time.

Vehicles also expose electronics to constant mechanical stress. Vibration from engines, road conditions, and chassis movement can loosen poorly designed parts or cause internal micro-cracks that shorten service life. Hence, manufacturers emphasize vibration-tolerant designs that can withstand the mechanical fatigue inherent in automotive use. Moreover, automotive-grade components are expected to function reliably over a long lifecycle.

Murata incorporates these design considerations into its product development and testing processes. The company designs its inductors and other passive components with materials and structures that balance miniaturization, thermal stability, and mechanical resilience. Murata subjects its products to stringent reliability assessments, including high-temperature storage, thermal shock, humidity resistance, and vibration testing to qualify for automotive deployment. These evaluations align with the Automotive Electronics Council's AEC-Q200 standard, which sets the industry benchmark for passive component qualification. Compliance with AEC-Q200 assures automakers that Murata's components meet established reliability criteria, making them suitable for safety-related systems and long-term use in harsh operating environments. [8]

Future Outlook: Preparing for Higher-Level Autonomy

The trajectory of autonomous driving points toward higher levels of automation, from today's Level 2+ driver assistance to Level 4 and eventually Level 5 autonomy. Achieving this progression requires continuous improvements in sensor precision, electronic integration, and component miniaturization.

Central compute architectures are expected to become the standard, consolidating perception, planning, and control functions into fewer but more powerful platforms. These architectures depend heavily on reliable sensors, capacitors, inductors, and communication modules.

As vehicles rely more on over-the-air updates and software-defined features, the role of robust and adaptable hardware components will be critical. Murata's future readiness and ongoing investment in silicon capacitors, ultrasonic sensors, and wireless modules ensure that it can continue to support OEMs as they move toward higher-level autonomy.
For more information, explore Murata's full lineup of automotive-grade solutions and learn how these technologies can support your next design.

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