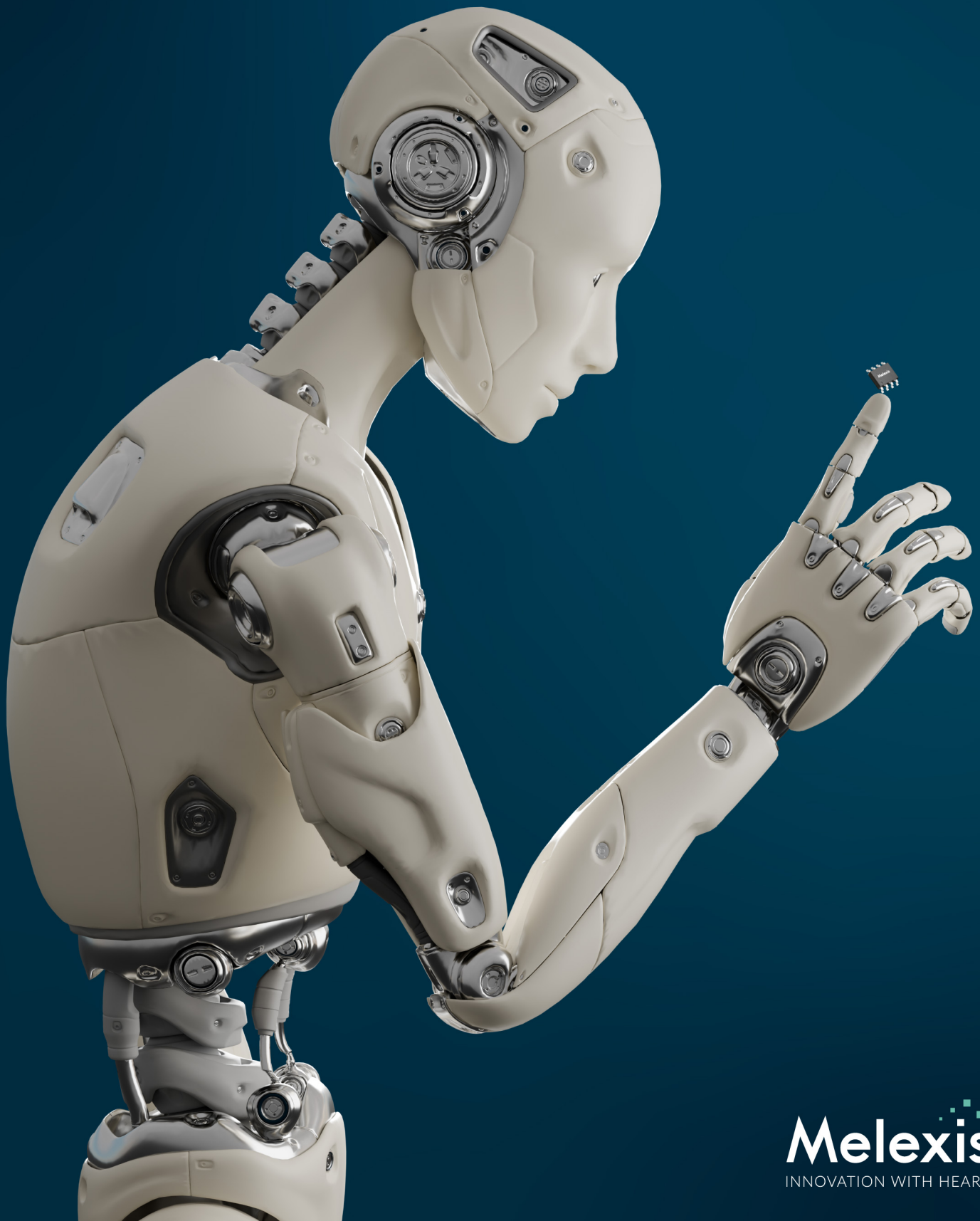


# Robotics e-Guide



# Engineering the Future of Robotics: Mastering the Integration of Enhanced Sensory Capabilities

Imagine a robot that can navigate chaotic environments with the finesse of a human – an entity capable not only of recognizing obstacles but also of interacting with its surroundings with intuitive precision. Now, how close are we to achieving this vision and what challenges are holding robotics back?

The creation of truly intelligent, adaptable robotic systems arguably hinges on innovation in two key areas. First, the requirement for smart control is paramount, demanding both sophisticated software and high-performance hardware. In recent years, advances in artificial intelligence (AI) have helped to enable robots to interpret complex data streams faster and with greater accuracy, creating a level of autonomy and decision-making prowess closer to that of humans. Simultaneously, the relentless pursuit within the electronics industry to reduce transistor size, thereby enhancing the capabilities of semiconductors, provides a substantial boost to the processing power available for these controlling algorithms.

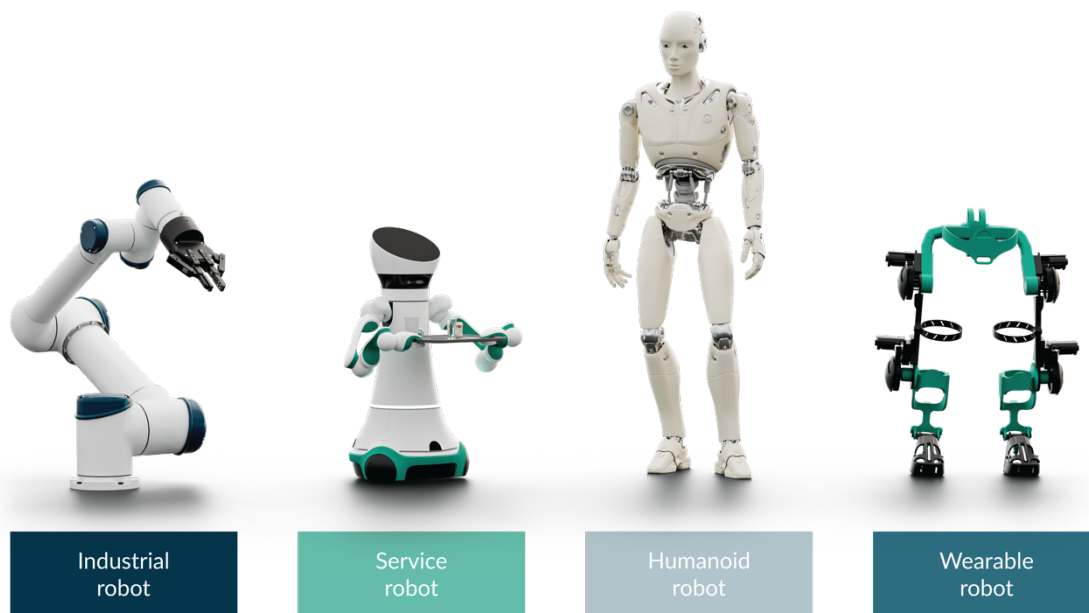
However, a robot's capacity to operate with flexibility and intelligence is entirely dependent on its ability to correctly perceive its movements and surrounding environment. This must be achieved through an array of sensors that provide a robot with information equivalent to human senses, such as temperature, vision, auditory perception, and tactile feedback.

Despite the rapid evolution of robotics, the challenge of providing machines with a level of sensory perception that approaches human dexterity and decision-making is still significant. Traditional sensor systems can often fall short when confronted with the complexity of challenges faced in robotics applications. Integration challenges, high manufacturing costs, and the lack of standardized design methodologies continue to impede the realization of truly responsive and safe robotic platforms.

Melexis, known for its longstanding innovations in automotive and industrial semiconductor sensing, has recently expanded its expertise into the realm of robotics. With an engineering-first mindset, Melexis offers comprehensive sensor solutions designed to simplify integration challenges while delivering unmatched performance. Within this guide, we will explore today's robotic market trends, applications and challenges before exploring the pivotal role of sensor technologies in redefining robotics and how they can help engineers overcome the technical and economic hurdles that prevent the mass realization of cutting-edge robotic systems.

## Market Overview: Trends, Applications, and Challenges

Historically, industrial automation has been a key market for robotics, with manufacturing and distribution leading early adoption, and these sectors remain crucial in its ongoing evolution. Developments in sensors, power electronics, and control algorithms, combined with the use of virtual digital twins for extensive training, are leading to significant improvements in the performance of robotic arms, automated guided vehicles (AGVs), and other industrial automations like collaborative robots (cobots).



click [here](#) to see Melexis' exact definitions of robot types and mobility options

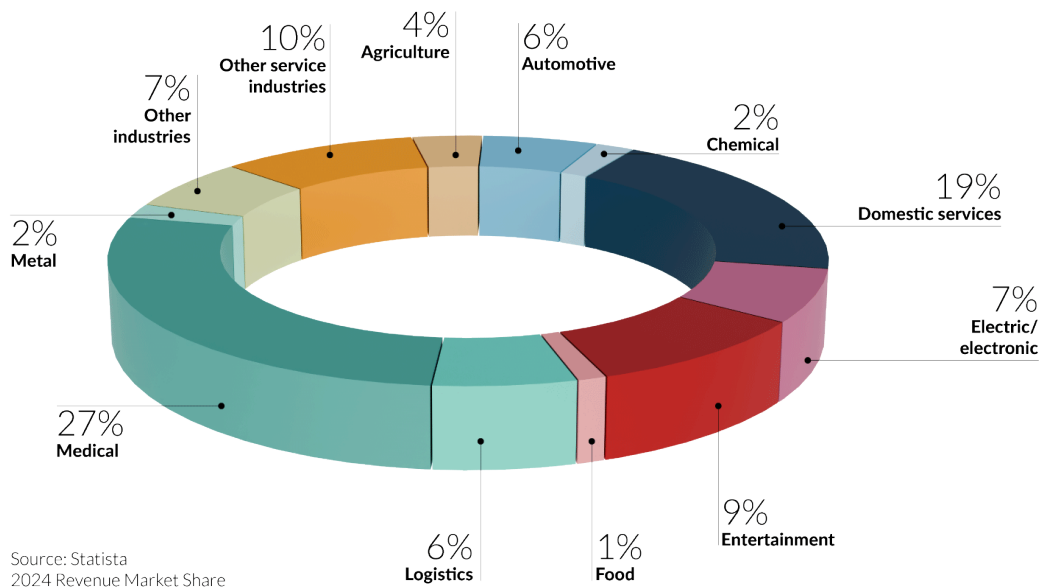
In recent years, there has been a significant increase in the demand for collaborative robots. In 2023, the International Federation of Robotics (IFR) found that cobots made up 10.5% of the total 541,302 (approximately 56,837)<sup>1</sup> industrial robots installed – a significant increase from just 14,100 cobot installations in 2018<sup>2</sup>. Designed for safe human-robot collaboration, these machines are expanding the uses of robotics in diverse fields such as healthcare, hospitality, and home assistance, whereby human-to-machine interaction must be significantly closer.

This shift from industrial to all-encompassing encapsulates much of the development seen within the robotics industry. Engineers are striving to develop intuitive and safer robots for domestic and commercial service environments, which in turn is demanding more sophisticated perception, as robots must interpret subtle physical and environmental cues beyond routine tasks, challenging conventional sensor systems and design. Historically confined to controlled environments like labs and factories, robotics is expanding into much more varied applications. Furthermore, this trend is

<sup>1</sup> <https://ifr.org/ifr-press-releases/news/how-robots-work-alongside-humans>

<sup>2</sup> <https://ifr.org/ifr-press-releases/news/robot-investment-reaches-record-16.5-billion-usd>

set to accelerate and many of the next generation of robots will need to navigate uncontrolled and unpredictable spaces.



With this technological progress and increasing demand for smarter and more diverse machines, the robotics sector is undergoing a period of rapid change.

These evolving trends and emerging challenges are driving robotics into a variety of new fields. In the following section, we explore the key application areas that illustrate the diverse impact of robotics – from domestic environments to advanced industrial and service applications.

## Key Application Areas

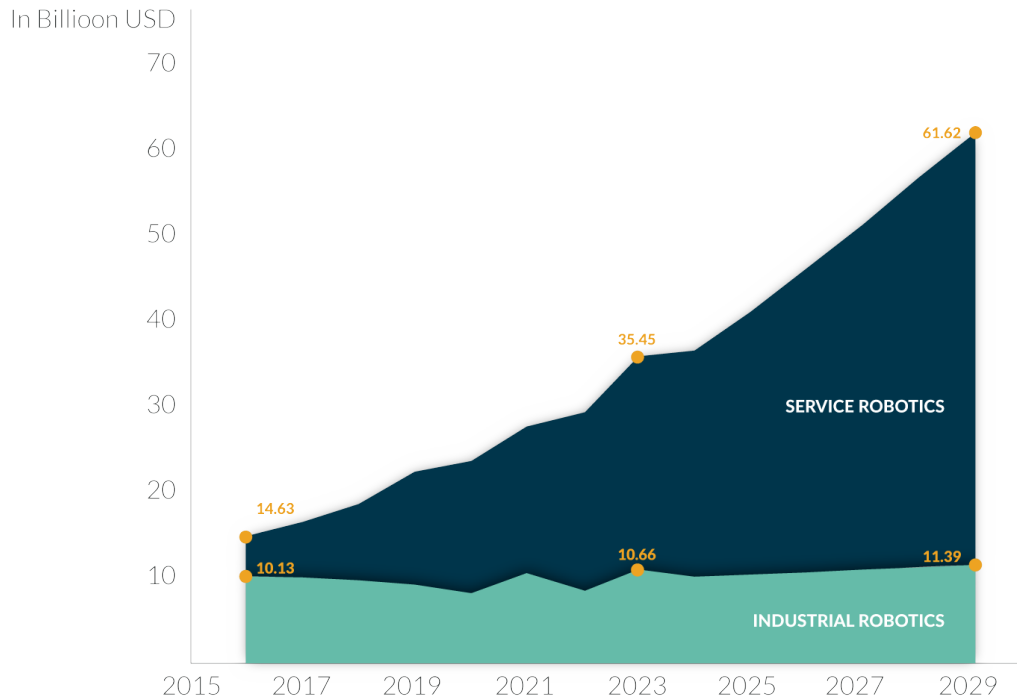


The robotics market is rapidly expanding into new deployments, with continuous innovation creating new opportunities and applications across sectors as varied as manufacturing to healthcare. The enduring strength of traditional industrial markets is being complemented by the explosive growth of new sectors, making it an ideal time for robotic systems to reshape both industry and societal landscapes, providing they can overcome critical scaling challenges.

### Domestic and Healthcare Robotics

Domestic robots are evolving from simple automated vacuum cleaners to sophisticated assistants, such as robotic waiters, capable of interacting in often unpredictable environments. Concurrently, the healthcare sector is creating service robots to improve patient care, alongside commercially available wearable robots, like exoskeletons, that further develop human-machine interfaces and positively impact lives. In both of these rapidly growing sectors, robotics require the highest levels of safety, reliability, and control, particularly when robots operate close to people. Furthermore, compared to industrial sectors where the end users are experienced engineers, robots working in domestic or healthcare environments must operate in unpredictable scenarios near people unfamiliar with robots, demanding truly intelligent operation.

Although creating safe, smart robots is a major hurdle, it's not impossible, and in fact, the professional service robotics sector is booming, exceeding the growth of industrial robotics due to increasing market demand and broader commercial applications.



Source: Statista

This increase stems from a global rise in the demand for automation to perform services and daily tasks, and from the need to bolster areas facing population aging and labor shortfalls. As professional service robots become integral to both commercial and domestic environments, the market cap is projected to reach US\$40.58 billion by the end of 2025, representing the majority share of the total robotics market.

### Collaborative Robots (Cobots)

Cobots are gaining traction in manufacturing and distribution due to their ability to enhance productivity by working safely alongside humans. Cobots succeed in labs and factories alike, because of their sensitivity to human interaction and the operational flexibility they offer over traditional and sometimes restrictive automation. Their capacity to subtly sense and react to human colleagues' actions, almost anticipating their needs, is critical for operational efficiency and, more importantly, safety. Once again, although AI is crucial for the market's success, high-precision feedback systems are also necessary for environmental awareness and fine motor control tasks, ensuring safe and efficient human-robot interaction.

The utilization of cobots is already widespread in traditional manufacturing environments, such as material handling, quality control, and assembly, but new applications continue to emerge. Market analysts Statista predict a nearly 33% compound annual growth rate (CAGR) for the cobot market between 2020 and 2030. While the market size was around US\$475 million in 2020, by 2030 this CAGR will see the market size grow to approximately US\$8 billion in 2030, showcasing the vast opportunities for innovation and application development<sup>3</sup>.

<sup>3</sup> <https://www.statista.com/statistics/1239304/size-of-the-collaborative-robot-cobot-market/>

## Industrial, Manufacturing and Automation

Industrial automation continues to expand with cobots, mobile automated guided vehicles (AGVs) as well as stationary robotic arms, industrial manipulators, precision positioning systems, amongst the many robotic systems that serve a wide range of critical global industries. Even humanoid robots are undergoing trials in real-world industrial settings, such as at the BMW Group Plant in Spartanburg, South Carolina<sup>4</sup>.

The ever-increasing adoption of new automation technologies in industrial, manufacturing, and even agricultural settings is driving the constant need for enhanced quality control, precision assembly, and operational costs in high-speed environments. These driving forces are joined by broader trends such as Industry 5.0 – a shift from digital connectivity to human-centric manufacturing, where robotic systems, including cobots, work in closer collaboration with human operators to deliver greater customization, sustainability, and resilience.

Likewise, software-defined manufacturing is reshaping production lines by leveraging real-time data, advanced analytics, and flexible software systems. This dynamic approach empowers manufacturing setups to quickly adapt to fluctuating demands and customized order requirements, but it also places increased technical demands on the underlying robotic systems and automation, needing greater system overheads and performance to permit shifts in functionality.

In parallel, smart agriculture is emerging as a significant growth area. Here, advanced robotics, sensor technology, and data analytics are revolutionizing farming, creating precision agriculture, better resource management, and higher yields to meet the rising global demand for food, and simultaneously spurring further robotic innovation. However, once again, the market opportunity presents new challenges in system costs and durability, particularly concerning temperature and vibration.

## Humanoid Robots

Though humanoid robots are frequently depicted in popular culture, the creation of realistic counterparts that can have an actual impact on society is not quite there yet. Humanoid robots offer the ultimate benefit to the global community by being able to mimic the dexterity, balance, and capabilities of humans, thus allowing them to seamlessly integrate into our world.

Achieving this level of performance requires an even higher level of control and integrated sensory inputs to coordinate complex, lifelike movements, however, the industry is continuing to edge forward and more market ready solutions are rapidly emerging.

Today, humanoid robots are being developed for advanced interactive service roles like customer service, waiting tables, and education, as well as for industrial applications needing human-like responsiveness for complex decision-making, nuanced interactions, or unsafe tasks like certain manufacturing tasks or jobs in extreme weather.

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<sup>4</sup> <https://www.bmwgroup.com/en/news/general/2024/humanoid-robots.html>

Although the development of humanoids presents unique challenges in sensor integration and control, the potential benefits of robots that can effectively navigate as we do, using the countless tools and systems that already work for humans, is substantial. Humanoids promise not only to expand the frontiers of automation but also to foster new applications that seamlessly blend human intelligence with machine efficiency, ultimately redefining the boundaries of robotic performance, but unlocking their potential is up to today's engineers.

## Challenges Facing the Robotics Market

Building robots that mimic the dexterity of humans, not just in controlled settings, but in dynamic, unpredictable situations, requires a seamless synergy of sensor performance, intelligent control, and efficient power systems. For engineers, this requires navigating several challenges, some at the system level and others inherent to underlying components.

At the heart of this struggle is the intrinsic complexity of integrating a multitude of sensor systems into a cohesive, responsive unit. Engineers must reconcile diverse data streams, from tactile, positional, and torque sensors, into a unified framework that a robot's control system can process in real time. This task requires not only exceptional sensor precision but also seamless integration and scalability.

Adding to this complexity are the economic pressures of robotics design. High-performance control electronics and sensor solutions come at a premium, making it challenging to balance cost with the uncompromising demands for efficiency, reliability, and safety. Engineers must demonstrate that investing in advanced technologies can deliver measurable performance improvements – an imperative that often tests tight budgets and operational constraints.

Furthermore, the robotics industry continues to grapple with a lack of standardized design methodologies in new applications. With numerous manufacturers offering proprietary sensor solutions, achieving interoperability, or even just finding the optimal solution, can be a significant hurdle. This fragmentation forces engineers to devise bespoke integration strategies, further complicating development timelines and impeding the scalability of robotic platforms.

To address the sophisticated demands presented by these application areas, engineers require sensor technologies that offer not only high performance but also seamless integration that supports mass production and lower costs. The next section details Melexis core sensor solutions, which are engineered to deliver the performance necessary for safe, efficient robotic operations.

## Technology Under Focus: Unlocking Advanced Sensing in Robotics

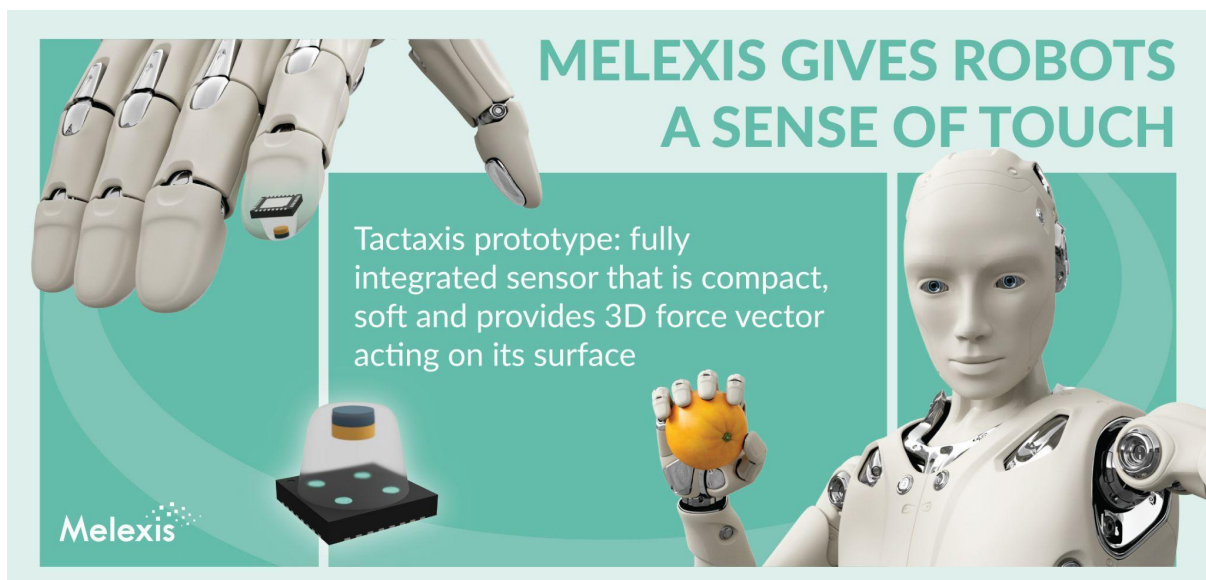
Melexis' cutting-edge sensor technologies have been meticulously engineered to address the multifaceted demands of modern robotics. Harnessing its extensive automotive and industrial experience, its engineering teams have worked with the robotics market to develop new core solutions tailored to the sector's and engineers' requirements.

Within this section, we will explore its three core robotics products – Tactaxis® and Arcminaxis® – which are designed to enhance robotic sensing and control. The succeeding section will then examine its extensive portfolio of wider sensing and driver solutions that are well suited for robotic environments.

### Tactaxis®: Giving Robots a Sense of Touch

At the heart of next-generation robotic systems lies the need for tactile perception – an attribute long associated with human dexterity. Though robots have possessed visual and auditory capabilities for a while now, tactile sensing has remained significantly limited or absent.

By capturing 3D force data, Tactaxis® provides real-time tactile feedback that is critical for both safe human-robot interactions and precise operational control. Each tactile pixel (taxel) consists of a magnet which is embedded into a soft elastomer material above a Triaxis® 3D magnetic sensing IC. This unique arrangement creates a soft contact interface, emulating the attributes of human skin and providing unmatched sensitivity so that detection of even small amounts of force will generate a response.



The sensor's construction enables it to measure normal forces up to 5 N and shear forces up to 2 N with impressive precision at the sensor level. A force resolution of 30 mN allows robots to detect weight changes as small as 3 grams, improving their ability to sense subtle force variations and dynamically adjust their grip and manipulation. This is particularly advantageous in applications such as stationary articulated arms, where

nuanced tactile feedback can prevent damage to delicate objects and ensure secure handling, as well as future service and healthcare robots where it provides the precision needed to physically interact with humans without harm.

Moreover, the sensors accommodate an extended force range up to 15N, although with decreased accuracy. This overhead helps to address scenarios in uncontrolled environments where temporary impacts and collisions are possible, and where robotic systems may experience high transient forces beyond the application's typical operating range.

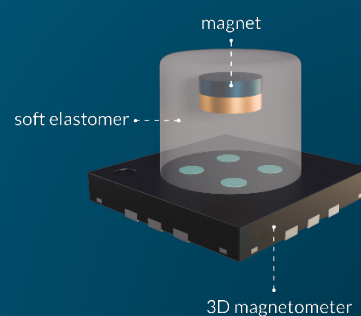
For engineers looking to integrate tactile sensing, Tactaxis® technology provides a scalability that will suit a wide range of physical shapes. The sensor's ability to be configured into arrays means that complex surfaces or multi-fingered robotic hands can be outfitted with a cohesive tactile sensing network. These configurations are vital for humanoid hands, wearable prosthetic devices and exoskeletons, and even rehabilitation robots where each application demands the integration of multiple tactile points to achieve human-like touch sensitivity.

Beyond 3D sensing functionality and scalability, Tactaxis® is engineered for practical integration. Measuring a mere 6 x 6 x 4.4 mm<sup>3</sup>, the highly compact taxels are ideal for tight spaces and their gradiometric approach eliminates errors caused by stray magnetic fields. Furthermore, the design's inherent robustness, combined with its -20°C to 85°C operating temperature range, guarantees reliability in a variety of environments. Furthermore, unlike alternative optical technologies, the Tactaxis sensor's fully integrated design and semiconductor fabrication process allow for the high-volume production of factory-calibrated sensors, resulting in substantial cost and reliability improvements.

By providing engineers with a sensor that is both highly sensitive and resilient, Tactaxis® can enable engineers to pave the way for innovations in adaptive grasping and nuanced force control-capabilities that are essential for the next generation of collaborative, service, and humanoid robotics.

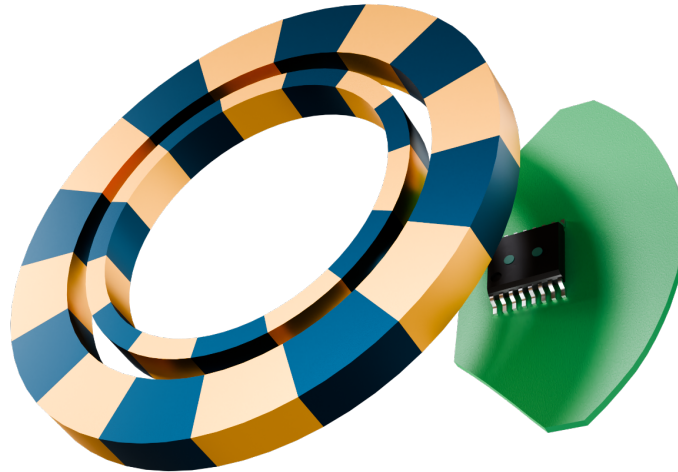
## Tactaxis® in Action

In practical terms, the integration of Tactaxis® into a robotic design leads to enhanced adaptive grasping and more natural, human-like interactions. Robots equipped with the tactile sensor can handle delicate objects more securely, respond swiftly to unexpected obstacles, and perform fine manipulation tasks with improved accuracy. The capacity to detect both normal and shear forces enables a genuine 3D representation of grasping mechanisms, which, in robotic applications, can result in enhanced safety within domestic, healthcare, and collaborative industrial settings, thereby increasing operational efficiency and user confidence in robotic systems.



## Arcminaxis®: Precision in Position and Speed Sensing

At the core of many robotic applications lies the critical need for precise, reliable motion control. Arcminaxis® has been developed by Melexis to meet this challenge, delivering advanced position and speed sensing capabilities that help robots to operate with exceptional precision, while cutting the cost and integration considerations typically associated with rotary encoders.



Drawing upon Melexis' patented Triaxis® technology, Arcminaxis® integrates a unique dual-track magnet design and innovative on-chip calibration to achieve a resolution of 18 bits over a full 360° range – capturing even the most minute positional changes with remarkable repeatability.

This ground-breaking technology utilizes a Vernier-type magnet with a Master track and a Nonius track to measure two orthogonal magnetic field components – axial and tangential. Using four unique signals and sophisticated algorithms, the system effectively reduces crosstalk from the master track, allowing precise Nonius angle extraction. Arcminaxis then further minimizes harmonic distortions stemming from mechanical misalignments such as eccentricity and residual magnetic interference, while a Look-Up Table (LUT) compensates for non-linearity caused by magnet imperfections.

This multi-axis sensing system and sophisticated signal processing allows for flexible assembly, with a placement tolerance of  $\pm 0.5$  mm between the magnet and sensor and the ability to accommodate larger magnet poles as well as a 1.5 mm air gap.

For engineers concerned with robotic design assembly and scalability, the inherent flexibility of Arcminaxis® significantly reduces mechanical complexity, allowing for simple production, improved long-term reliability and a more cost-effective solution compared to conventional high-performance optical sensors.

The first product in the Arcminaxis® range, the MLX90384, is housed in a compact TSSOP-16 package, and comes complete with an integrated magnet and a software suite that features a dedicated calibration routine.

# MAGNETIC POSITION SENSOR ICs

Arcminaxis™ encoder for robotic joints

MLX90384

- High-precision, up to 18-bit
- One IC for various magnets
- Generous placement tolerance +/- 0.5mm
- Large air gap, sensor to magnet 1.5mm



Its pitch-independent design eliminates the need for exact magnet-sensor matching, while a high-speed 6MHz SPI interface supports precise acquisition of angular position, speed, and rotation data, along with error detection and in situ calibration. The MLX90384 solution is also available as part of a ready-to-run evaluation kit, pre-assembled, pre-calibrated, and equipped with a pre-programmed microcontroller, allowing engineers to quickly assess this advanced technology.

## Impact on End Applications

In industrial automation, Arcminaxis® provides the precise positional feedback essential for controlling stationary robotic arms, mobile automated guided vehicles (AGVs), and industrial manipulators – ensuring repeatable, accurate motion that enhances both productivity and quality control. Furthermore, the 1.5 mm air gap lets the sensor and magnet mount safely within the robotic joint, preventing collisions that could damage other encoders.

In cobots, its high-resolution sensing supports safe and efficient human-robot interactions by enabling smooth, coordinated movements. Additionally, in applications such as exoskeletons and wearable robotics, Arcminaxis® offers the reliability and flexibility needed to track joint positions under dynamic loads, with the smart integrated calibration routine enhancing overall precision.

Ultimately, Arcminaxis® transforms the challenge of motion control into an opportunity for innovation capable of exceeding the limitations of existing optical encoders. By delivering a sensor that combines high performance with ease of integration and cost-effectiveness, Arcminaxis® aims to assist engineers in pushing the boundaries of robotic precision, letting them scale their designs with lower costs.

# Melexis Robotic Sensing Integrated Circuit (IC) Portfolio

Beyond its core robotics solutions, Melexis offers a comprehensive portfolio of sensing Integrated Circuits (ICs) that can help engineers to design next-generation robotic systems. This includes components such as position sensors, temperature sensors, current sensors, and latch & switch ICs – each designed to meet the unique challenges of modern robotics.

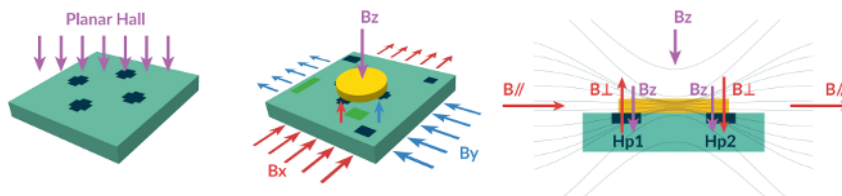
## Position Sensors for Enhanced Control

Position feedback is a fundamental aspect of safe and accurate robotic movement, and Melexis has a wide range of position sensing IC solutions based on both its magnetic and inductive technologies.

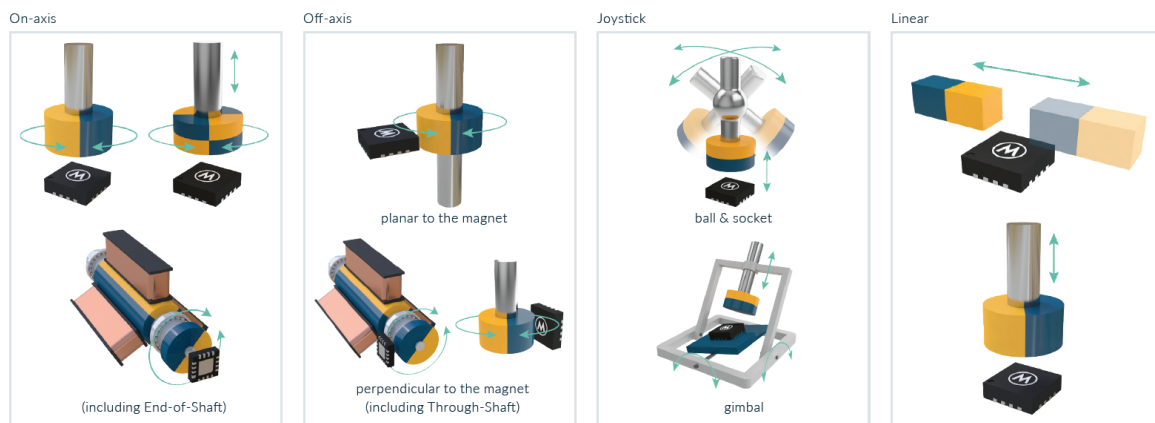
### Triaxis® Hall Technology

Suitable for a wide range of robotic systems, the Triaxis® range features performance and value-optimized solutions, including the Triaxis® Resolver, Triaxis® Encoder and Linear Hall product ranges. Unlike traditional Hall sensors, which only measure magnetic flux perpendicular to their surface, Triaxis® sensors use patented technology to measure all three magnetic flux components (BX, BY, and BZ) within a single IC.

### Triaxis® integrated magnetic concentrator Hall



Employing a unique Integrated Magnetic Concentrator (IMC), the three magnetic components facilitate the development of 2D or 3D sensors capable of detecting rotary (angle), linear (stroke), or joystick movement, as well as 3D magnetometers that output individual magnetic components (BX, BY, BZ).



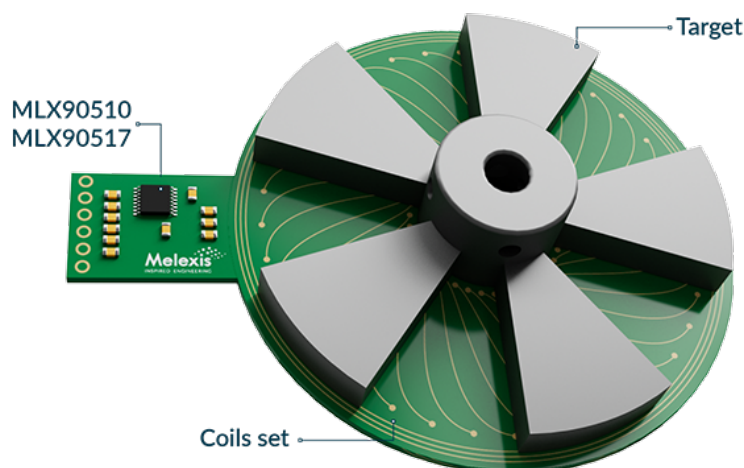
Triaxis® enables the use of smaller, less expensive magnets while offering greater flexibility in assembling complex robotic systems. This results in stable angle calculations, even with variations in temperature, magnetic fields, and mechanical tolerances. Stray field immunity (SFI) modes (available on select models) and a broad range of IC packages – SMD, PCB-less, and Melexis' advanced solutions further enhance system integration.

Discover more about the Melexis Triaxis® portfolio via the [parametric search](#) available on the overview page.

## Inductive Technology

As an alternative, or part of a combined heterogenous sensing deployment, Melexis also offers a selection of inductive position sensors, resolvers and encoders. Designed for rotary and long-stroke linear applications (up to 30cm), Melexis inductive position sensor ICs are perfect for industrial automation, especially actuators. Featuring a robust design, they provide highly accurate, real-time performance while remaining immune to electromagnetic interference and thermal drift. With flexible outputs, it's engineered for seamless integration into a range of robotics systems, offering reliability and precision for both manufacturers and end users.

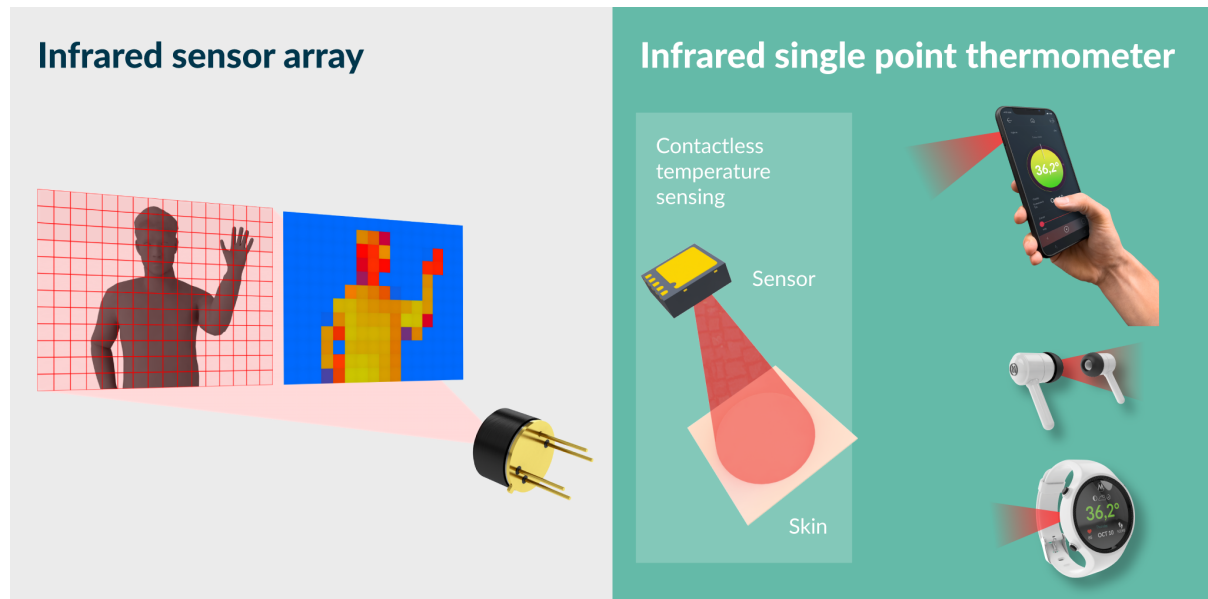
Also available in Melexis' inductive portfolio are analog inductive resolvers. These ICs deliver high-accuracy rotational feedback ( $\pm 0.36^\circ$  electrical) for high-speed electric motors, operating up to 240,000 electrical rpm and remaining immune to stray magnetic fields (per ISO 11452-8).



The three-phase coil design simplifies linearity optimization, and the decoupled input and output design improves electromagnetic compatibility and ensures consistent output amplitude despite air gap variations affecting signal strength input.

## Temperature Sensors: Safeguarding Performance in Variable Environments

Temperature monitoring is vital not only for the robot's internal health but also for ensuring environmental safety. From robotic joint monitoring to off-board charging, Melexis' temperature sensors are engineered for a diverse range of robotic deployments where precise temperature management is critical. Its portfolio includes highly accurate single-point thermometers, including plug-and-play digital infrared thermometers in a TO-can package, as well as advanced infrared sensor arrays.

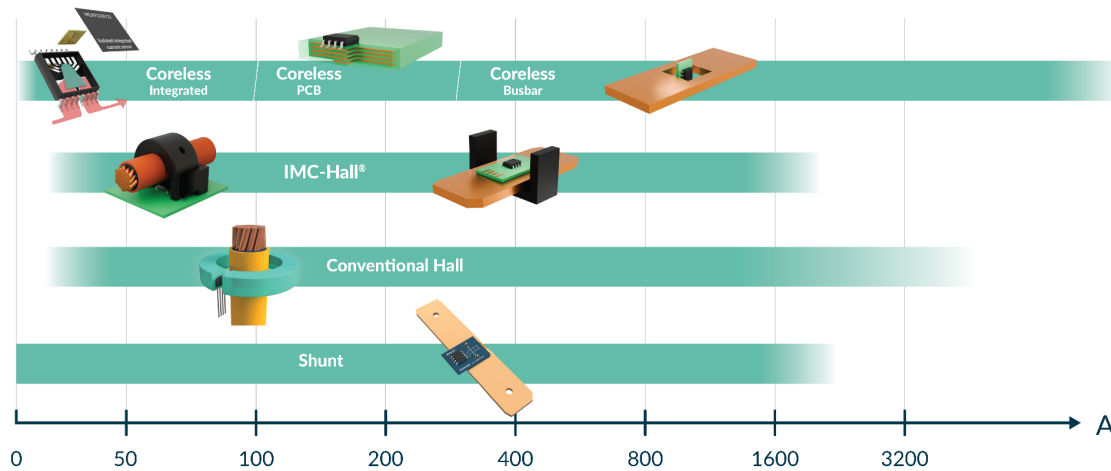


Melexis thermal imager ICs measure object temperatures from  $-40^{\circ}\text{C}$  to  $300^{\circ}\text{C}$  with typical accuracy of  $\pm 1^{\circ}\text{C}$  across its range. Its  $32 \times 24$  pixel array can also be used for sophisticated AI-backed operations such as person and gesture recognition, providing a cost-effective and accurate way to improve robotic navigation and guidance.

Furthermore, Melexis offers a supporting evaluation board for engineers, with its software enabling temperature measurement, visualization, and logging, while its HID compliance and USB interface expedite the initial setup process.

## Current Sensors for Optimized Power Management

Efficient power management is a cornerstone of advanced robotics. Current sensors from Melexis provide engineers with critical insights into energy consumption patterns, both within robots and support charging and power systems, enabling them to optimize performance and reduce overall power wastage.



Whether your power monitoring needs are simple or sophisticated, Melexis offers a suitable sensor. Its portfolio ranges from conventional Hall and shunt sensors to innovative IMC-Hall, Coreless Integrated, and Coreless External Primary Sensors, with each model offering a different set of functionality well suited to several robotics applications.

### Other Supporting Technologies

Melexis also provides a range of supporting ICs that elevate robotic system performance. Its lighting driver ICs, including the innovative MeLiBu technology, can enable dynamic, energy-efficient visual indicators that enhance human-robot interaction by signaling operational status, errors, or mode transitions, critical for service robots and cobots in environments where clear visual feedback is essential. Similarly, Melexis fan and pump driver ICs deliver precise control over cooling fans and fluid pumps, while its pressure sensor ICs offer accurate, real-time monitoring for pneumatic and hydraulic systems as well as environmental sensing.

Together, these supporting solutions form a holistic portfolio that simplifies design and integration, enabling engineers to build next-generation robotic systems that are both efficient and responsive.

## Melexis Engineer-Centric Approach

Amidst these challenges and the complexity of the robotics markets, electronic manufacturers must prioritize the needs of engineers. The focus must shift from merely supplying components to providing comprehensive and well-supported solutions that streamline development, resolving aspects of the engineering effort through the component's inherent design.

By offering robust, integrated sensor technologies and well thought out application support — like, SDKs, development kits, webinars, and detailed application documentation — Melexis is dedicated to assisting engineers. Rather than simply being a supplier of components, Melexis works to position themselves as a collaborative supporting force, enabling engineers to drive innovation in their own right.

Today's market underlines that the future of robotics hinges on the ability to integrate sensory inputs that allow machines to perceive and interact with their environments in a human-like manner. As engineers continue to push the boundaries of what is possible, the adoption of inventive and high-performance sensor technologies will be the key to unlocking safer, more efficient, and economically viable robotic systems.

Melexis is dedicated to advancing robotics by providing engineers with robust, integrated sensor solutions and comprehensive support. Building on its decades-long heritage in automotive and industrial semiconductor technologies, and by collaborating with industry leaders and research institutions, we refine its sensor technologies to address real-world applications, ensuring that its solutions remain practical and adaptable. Melexis' philosophy, "Innovation with Heart," underlines its commitment to developing solutions that enhance safety, efficiency, and human-centric design in robotics.

## Conclusion: Looking to the Future

While AI often dominates the headlines, the integration of new or more advanced sensing technologies is also revolutionizing the field of robotics, bringing us ever closer to machines that can match the sensitivity and precision of human perception. Melexis' comprehensive sensor solutions — from the tactile sophistication of Tactaxis® to the precise positioning of Arcminaxis® — are designed to support this revolution, supporting engineers to overcome integration challenges and accelerate innovation.

As the robotics industry continues to evolve, Melexis remains dedicated to continuous research and development. Melexis' vision for the future is clear: to enable the advanced sensing technologies that seamlessly integrate with intelligent control systems, supporting engineers to create, at significant volume, robots that are not only highly efficient and reliable but also capable of enhancing human potential. We aim to help engineers shape the future of robotics through innovation and forward-thinking approaches that address real-world challenges.

Melexis recognizes human-harmonious design is key to a successful robotics market and its strategic focus on outcome-driven innovation and supported solutions ensures

that every product we deliver is a step towards a future where robotics and human ingenuity coalesce to drive societal progress.

This vision is not just about providing technology – it is about building lasting partnerships. Melexis views every collaboration as an opportunity to learn, grow, and shape the future of robotics together with the engineering community. As we look ahead, Melexis' commitment remains steadfast – to drive technological progress while ensuring that the engineer is always at the heart of every innovation.

For more information, please visit Melexis' website or contact its dedicated robotics team at [robotics@melexis.com](mailto:robotics@melexis.com).



## Melexis Robotics Definitions

### Types of Robots:

- **Industrial Robots:** These robots are integral to manufacturing processes, performing precision tasks such as welding, painting, assembly of complex components, and material handling. Examples include articulated robotic arms used in automotive assembly lines and gantry robots used for picking and placing components in manufacturing.
- **Service Robots:** These robots are deployed for a variety of service-oriented tasks in diverse environments, from domestic to professional settings. Examples include vacuuming robots that autonomously clean domestic and commercial spaces, warehouse robots that sort and move inventory, telepresence robots in healthcare that allow doctors to interact with patients remotely, and agricultural robots such as those used for milking in dairy farming.
- **Humanoid Robots:** Humanoid robots are designed to resemble and function like humans, which can be advantageous in tasks that require interaction with human tools. They can be used in scenarios where the robot needs to navigate terrain or use equipment designed for humans, or in customer service roles where a human-like appearance may be more approachable.
- **Wearable Robots:** These robotic systems are designed to be worn by individuals, enhancing their physical abilities. Examples include powered exoskeletons that assist with lifting loads in industrial settings or provide mobility assistance for individuals with physical impairments.

### Interaction Types/ HRI (human-robot interaction):

- **Collaborative Robots (Cobots):** Cobots are designed to interact safely with human operators within the same workspace. They are more adaptable than traditional industrial robots, with easy reprogramming and redeployment capabilities. For instance, a cobot might be used for precision tasks such as circuit board assembly or in quality control processes where they can present items for inspection by a human colleague.
- **Cooperative Robotics:** These robots are designed to work in conjunction with other robotic systems or automated processes to achieve a shared objective. They coordinate their actions and share information to enhance overall efficiency and productivity. Examples include robots that work together on an assembly line or those that collaborate to manage inventory in a warehouse.

### Movement Types:

- **Stationary Robots:** These robots are fixed in one location and operate within a defined workspace. Examples include robotic welding stations in automotive manufacturing and immobile robotic arms used for precision tasks such as assembling intricate electronic devices.
- **Mobile Robots:** These robots have the capability to navigate various environments. Examples include autonomous mobile robots (AMRs) that transport materials within a manufacturing plant or distribution center, and unmanned ground vehicles (UGVs) used in hazardous environments or for environmental monitoring.



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