Evolving Healthcare Technology: Murata's Role in Advancing Wellness Technology

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Few industries are as vital to society as hospitals and healthcare services; they're the backbone of emergency response and ongoing health management, ensuring both immediate and long-term patient well-being. However, the critical role of healthcare providers in modern society is challenged by a growing number of global issues such as increased pressure from aging and growing populations, rising costs, the ongoing effects of pandemics, persistent staffing shortages, the increase in chronic diseases and the demand for more sustainable operations.

These issues compound existing difficulties in delivering personalized care, maintaining patient privacy, and achieving improved patient outcomes, creating a perfect storm of pressure for many clinical institutes. In this ever-evolving landscape, advanced electronic-based wellness products are emerging as pivotal enablers of enhanced patient care, operational efficiency, and environmental stewardship. Technological advancements offer enhanced patient monitoring, optimized resource management, and improved treatment outcomes, extending care beyond traditional clinical settings while reducing waste and aligning with patient and institutional needs.

Behind the scenes, the electronics industry drives advances in wellness technology. Innovation in miniaturization, integration, perception, and intelligence fuels the creation of new medical devices capable of elevating services.

As a company long involved in all aspects of electronics development, Murata is well-positioned to drive healthcare innovation. It provides reliable and highly miniaturized electronic components that underpin countless medical devices and radically new solutions designed to transform the interaction between humans and wellness technologies. In this white paper, we will explore the sector's key challenges, trends, and opportunities within the healthcare market and examine how Murata's latest technologies can help usher in the next generation of healthcare.

2. Challenges, Trends, and Opportunities in Wellness Technology

Healthcare institutions are grappling with a multitude of escalating challenges, such as a shortage of staff and insufficient investment, which are exacerbated by increasing patient numbers and a higher frequency of illnesses. The scarcity of qualified personnel and challenges in staff retention due to issues like remuneration and workload, alongside expanding populations and extended life expectancies, are causing many facilities to struggle to deliver effective care.

While this strain is already evident, the World Health Organization (WHO) has projected that the challenge will grow and by 2030 there will be a shortfall of almost 10 million health workers globally, predominantly in low- and lower-middle-income countries . Optimizing time and maximizing the frequently demanding work of caregivers is a significant hurdle for healthcare providers striving to improve workforce efficiency. Nevertheless, technology is rapidly emerging as a crucial tool for achieving this goal, becoming integral to healthcare operations and transforming how providers interact with patients, manage data, and deliver care.

This success is in part due to how closely it aligns with healthcare's core needs: data. Whether we are talking about developing new drugs, refining workflows to save time, prepping a patient for invasive surgery, or managing complex chronic illness, medical professionals need data to drive their actions. Data is crucial to nearly all aspects of healthcare and, as a result, accounts for a staggering 30% of the world's total generated data volume.

For electronics engineers, integrating technology more deeply into healthcare, especially in the era of advanced artificial intelligence (AI), can help to improve data quality and processing, enabling healthcare professionals to provide better and more personalized care, greater operational efficiency, and accelerate vaccine development.

2.1. Delivering Excellent Wellness Technology

Traditionally, medical technology has consisted of largely static surgical, delivery, monitoring, or diagnostics equipment that is confined to clinical settings. However, a growing need for efficiency, accessibility, and improved patient outcomes is driving a shift toward technologies that can operate beyond these confines. Advances in electronics have opened the door to new methods of care delivery, minimizing inefficiencies and enabling continuous patient support in the comfort of a person's own home. Market projections indicate a compound annual growth rate of 7.96% for the home healthcare sector from 2024 to 2030 .

Wearable devices and compact healthcare systems exemplify this evolution, offering remote monitoring, early detection, and personalized care in real-time. These devices empower patients to manage their health proactively while reducing the strain on clinical institutions. Electronic engineers and specialists from multiple disciplines – including electronic, biomedical, and software engineering – are at the forefront of this transformation, tasked with creating systems that are not only functional and reliable but also seamlessly integrated into everyday life *(Figure 1)*.

Figure 1 – A number of wearable smart devices which can be designed to incorporate medical functionality (Source: Murata)

Miniaturization and advances in electronic assembly manufacturing have proven pivotal in meeting these demands, enabling the development of smaller, lighter, and more versatile devices. Innovations such as stretchable electronics are helping to redefine what is possible, allowing for innovations like patient monitoring systems that are both highly precise and exceptionally comfortable.

1 https://www.who.int/health-topics/health-workforce#tab=tab_1
2 https://www.grandviewresearch.com/industry-analysis/home-healthcare-industry

2.2. Driving Clinical Innovation

The miniaturization of electronic components is not only influencing the development of wearable medical devices, but it is also facilitating advancements in minimally invasive surgical equipment, drug delivery systems, and fixed monitoring systems. Minimally invasive surgical equipment, enhanced by the miniaturization of components, will see procedures becoming more precise, reducing patient recovery times and improving surgical outcomes. Drug delivery systems will also benefit from compact, electronically controlled mechanisms that ensure exact medication dosing, thereby enhancing treatment results.

Similarly, fixed medical monitoring systems that track a variety of patient vitals can be refined through integration and shifts in material composition to enhance the reliability of the monitoring systems and to enhance comfort while providing continuous care. This ongoing progression in medical devices, characterized by increased functionality in a smaller or more comfortable package, underscores the industry's commitment to efficiency and a patient-centered approach to healthcare delivery.

Electronic innovation should also assist in the healthcare industry's push for sustainability. Medical waste is a persistent challenge, and new technologies must address this by optimizing resources, extending the lifespan of devices, and supporting traceability throughout the supply chain to improve waste management. To ensure market success, and more critically meaningful application impact, engineers must design solutions with these goals in mind, ensuring that every step of development—from concept to deployment—prioritizes efficiency.

At the heart of medical advancements is a commitment from engineers to rethink how healthcare is delivered. Whether it's through continuous monitoring devices that reduce hospital visits or systems that automate routine tasks, technology is reshaping the interaction between patients, caregivers, and medical institutions. Engineers play a crucial role in this process, ensuring that the innovations of today are aligned with the real-world challenges of tomorrow.

By leveraging cutting-edge materials, compact designs, and connected systems, wellness technology can drive the healthcare sector into a new era. It is not just about incremental improvements; it is about reimagining what healthcare can achieve.

Figure 2 – Technology is at the center of modern medical institutes underpinning all areas of their services (Source: Murata)

3. Murata's Solutions For Wellness Innovation

3.1. Supporting Regenerative Medicine and Cell Therapy with the World's First Metal Cell Fractionation Filter

Regenerative medicine and cell therapy are gaining global attention for their potential to cure previously incurable diseases by replacing lost cells and functions. The success of regenerative medicine and cell therapy, however, depends on accurately and efficiently isolating viable cells from complex biological mixtures.

The drawbacks of traditional methods, such as centrifugation and polymeric membrane filtration, include slow speeds, the need for skilled operators, and the risk of contamination or damage to fragile cells. To solve these problems, Murata leveraged its extensive thin-film microfabrication expertise to create CELLNETTA - a groundbreaking metal-based cell fractionation filter offering precise, fast, and residue-free target cell separation.

CELLNETTA - a name combining "Cell," "Net," and the Italian word for "small," "Etta" - is constructed using Murata's proprietary thin-film fabrication methods. The result is a precise metal mesh with uniformly sized microscopic pores on an ultra-thin, biocompatible metallic substrate. Unlike conventional resin or fiber filters, this advanced construction minimizes cell adhesion and permits high-speed filtration without the need for pressurized pumps or complex apparatus *(Figure 3)*.

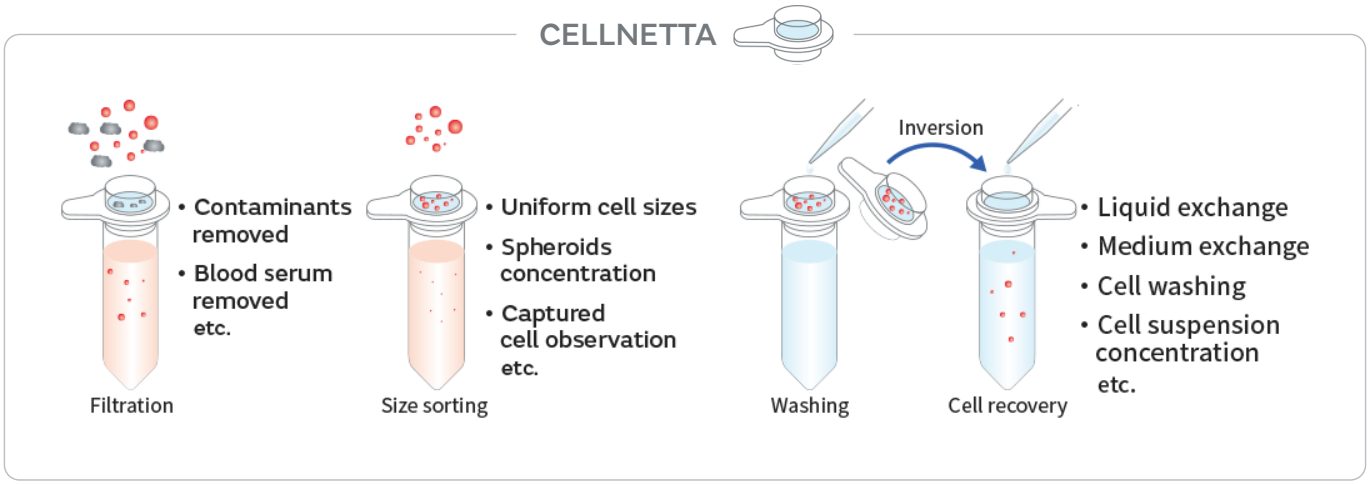

Figure 3 – The technology helps to significantly simplify cell recovery processes (Source: Murata)

Researchers can fractionate and concentrate specific cell populations simply by placing CELLNETTA on a centrifuge tube and pouring the suspension through the filter, reducing processing times from several minutes to mere seconds.

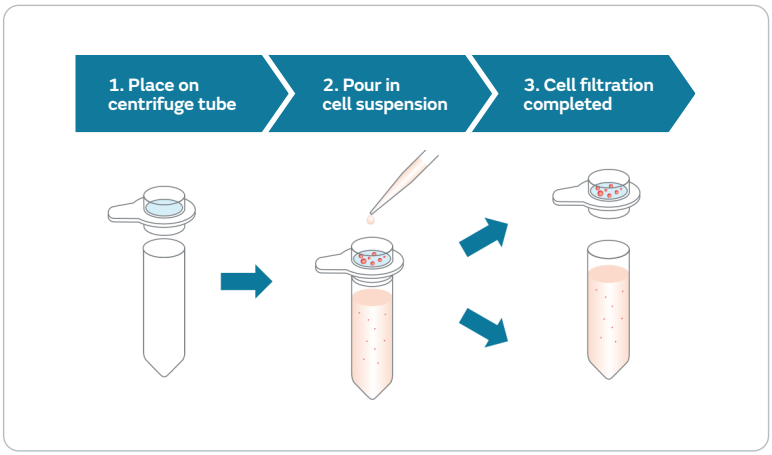

Figure 4 – Simply pour the cell suspension into CELLNETTA to sort cells by size. (Source: Murata)

In practical applications, CELLNETTA has demonstrated significant efficiency gains. For instance, a 50 ml phosphate-buffered saline (PBS) solution filtered in approximately 320 seconds using a conventional membrane filter can be processed in just 20 seconds with CELLNETTA. When compared to centrifugation, the contrast is even more pronounced, and a 10 ml suspension of HL-60 cells at $1x10^5$ cells/ml is separated in approximately 50 seconds with CELLNETTA, whereas a centrifuge may take 5-15 minutes.

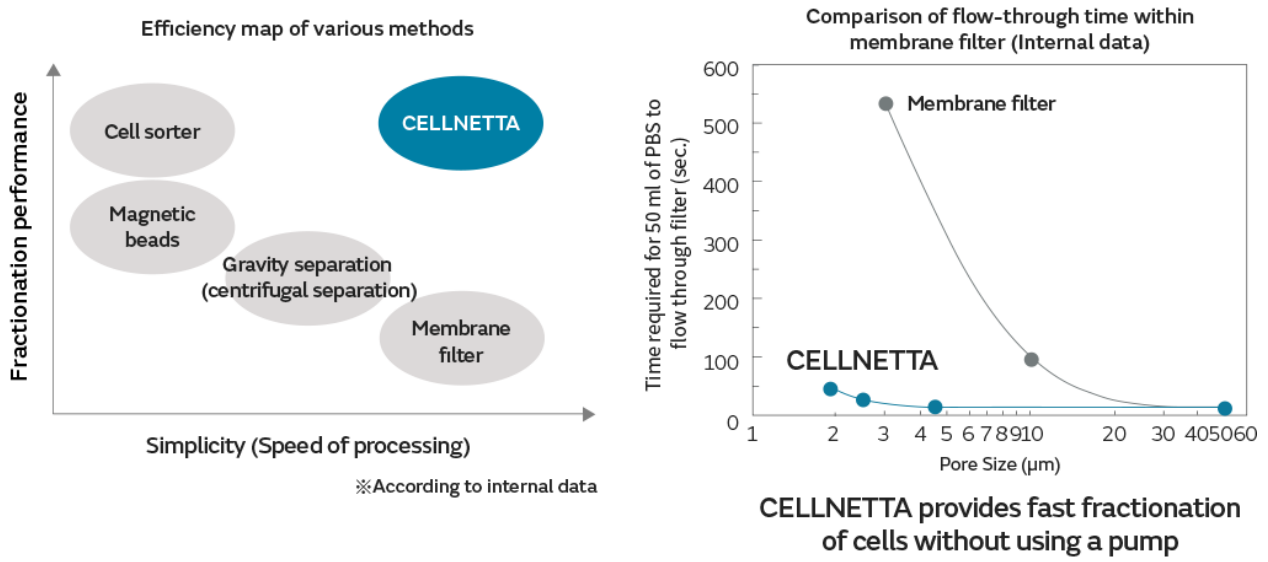

Figure 5 – CELLNETTA offers a different approach to cell recovery that doesn't compromise on performance or simplicity. (Source: Murata)

Available in six distinct mesh sizes (5 μm, 10 μm, 15 μm, 20 μm, 100 μm, and 200 μm), CELLNETTA can be tailored for diverse target cell dimensions and application types across regenerative medicine, biotechnology, agriculture, and energy sectors. Each filter is gamma-irradiated and individually packaged to ensure sterility and traceability, aligning with stringent research protocols and biosafety requirements. Regenerative medicine is becoming a major part of 21st-century healthcare, and tools like CELLNETTA will be crucial for streamlining one of the most critical steps in cell-based research. As the world's first metal cell fractionation filter designed for the fast and accurate selection and recovery of target cells from cell suspension, its innovative design removes the barriers of time, cost, and complexity inherent in traditional methods, allowing researchers to accelerate their R&D cycles and focus on developing transformative therapies.

3.2. Enhancing Patient Monitoring Through Stretchable Electronics

Patient monitoring is a critical element of healthcare delivery. Its application enhances the evaluation of patient stability and recovery in hospitals and provides valuable data for the long-term management of illnesses outside of hospitals, leading to more focused and life-improving interventions. Monitoring, however, is not without its difficulties. Securing equipment for a person is inherently problematic because the immediate environment can be tough on electronics, and patient movement may dislodge or damage electrodes and sensors. To allow for more insightful, comfortable, and reliable monitoring technologies, electronics themselves must become more like a second skin.

Following its key role in the development of flexible printed circuit boards (PCBs) the Stretchable and Elastic Sensor Array System (SESAS) is Murata's radical next step in circuit board composition. Going beyond the limitations of flexible substrate, SESAS offers the ability to stretch and deform without compromising electronic integrity *(Figure 6)*.

SESAS uses a soft and extremely thin substrate of 100 µm which provides up to 60% stretch and exceptional surface adhesive, with the ANSI/AAMI EC12 compliant Ag/AgCl electrodes capable of reliable and safe operation in close contact with the skin *(Figure 7)*.

In medical applications, SESAS provides an electronic sensing surface that can more naturally move with the user, helping to create medical monitoring devices that are more reliable and more comfortable for the end-user.

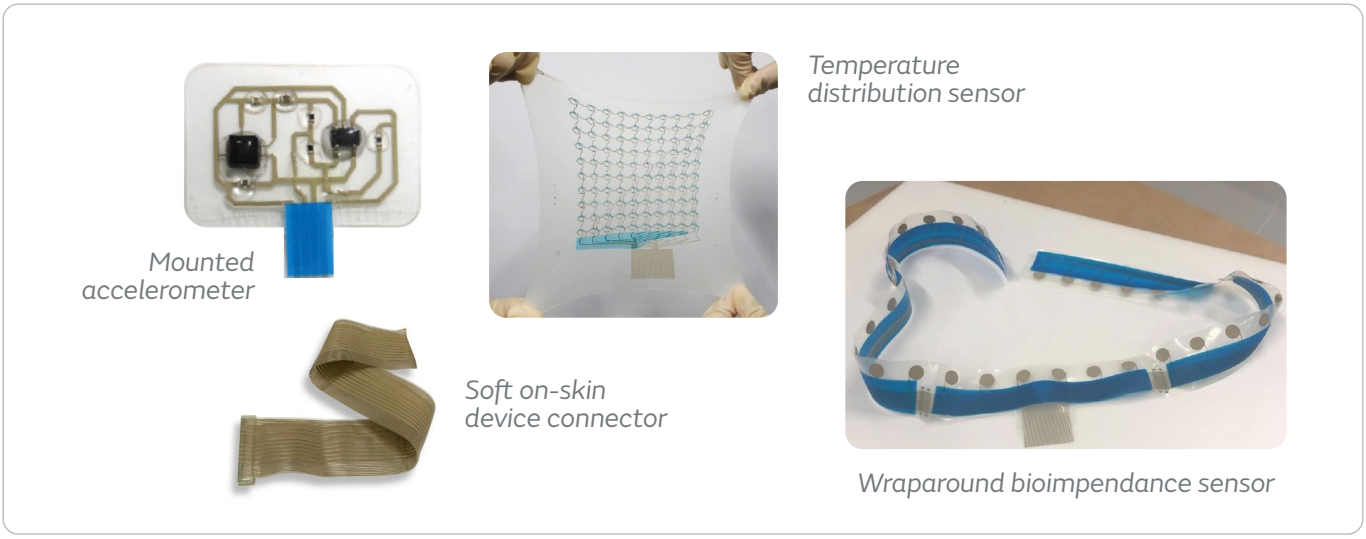

Figure 6 – SESAS can be used in a wide range of medical applications, such as those pictured above (Source: Murata)

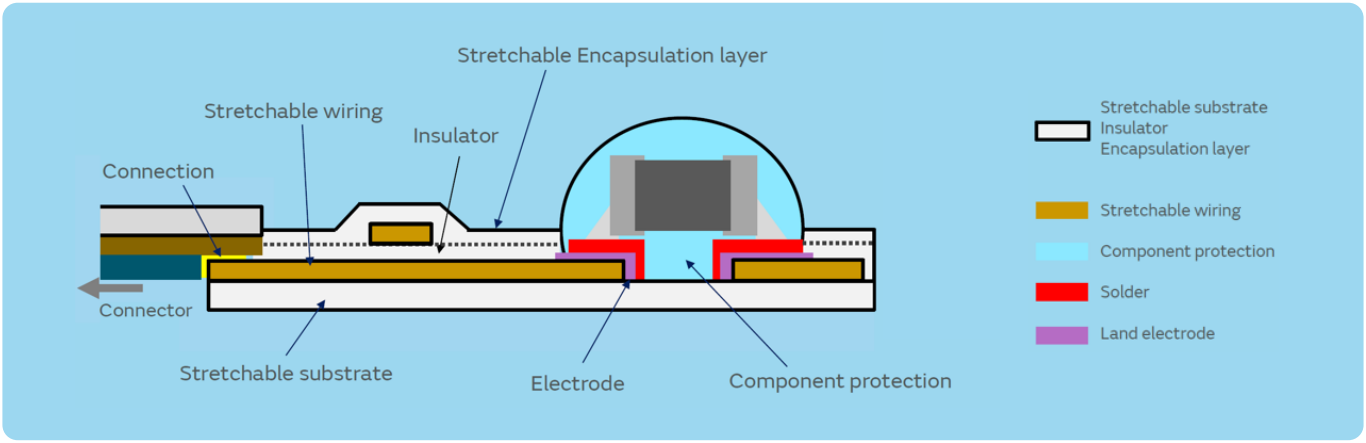

Figure 7 – SESAS unique composition enables it to stretch without compromising the electronics (Source: Murata)

Traditional patient monitoring systems are often uncomfortable for long-term use and even in short-term applications, they require precise placement, are prone to electrode detachment, and produce weak, and often interference-sensitive signals. Compared to traditional methods, Murata's SESAS and its stretchable printed circuit (SPC) construction offer superior performance in all aspects, especially in applications such as neonatal care, where comfort and safety are paramount. Furthermore, for busy medical staff, the thin construction that is made possible by integrating all electrodes and wiring on a single sheet allows for easy and comfortable, one-touch installation and removal from patients.

SESAS' monitoring performance is elevated by placing amplifiers closer to the electrodes, reducing interference (like patient movement) for more accurate data capture *(Figure 8)*, while the ability to incorporate extra features like optical, temperature, and acceleration readings expands the application possibilities.

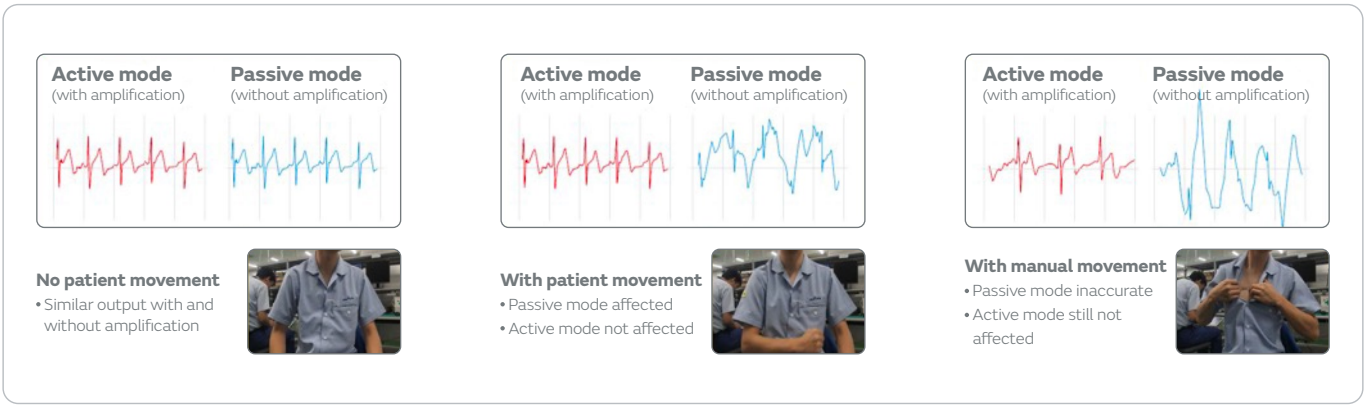

Figure 8 – SESAS' amplifier position helps to reduce interference caused by movement (Source: Murata)

For applications needing high precision monitoring and adaptability, such as monitoring moving joints, SESAS' soft, flexible, and adhesive material offers superior performance compared to existing technologies. Similarly, its elasticity and durability make it an excellent candidate for wearable systems that demand long-term and non-invasive monitoring.

To withstand the conditions present within these demanding medical applications, Murata has ensured the printed conductive tracks can be stretched repeatedly without disconnection. Testing demonstrates that SESAS exhibits >1GΩ insulation resistance even under high (95%) relative humidity at 40°C, as well as negligible resistance variation after 100 cycles of 20% elongation at a velocity of 7.8 mm/s *(Figure 9)*.

Moreover, Murata's simulation capabilities can predict and model track resistance changes, enabling customized track design and layout proposals that ensure long-term reliability tailored to the application's demands.

To accelerate product development and ensure application reliability, Murata goes beyond the role of a traditional electronics manufacturer for SESAS. Murata's engineering teams offer design support, reliability testing, failure analysis, and product customization, encompassing aspects such as ensuring wiring design flexibility, component mounting for flexibility, mounting part selection, semi-finished product performance inspection, and application-based environmental reliability testing. SESAS, combined with Murata's robust SPC support, creates a powerful platform that allows engineers to develop a wide array of innovative wellness applications, benefiting patients worldwide.

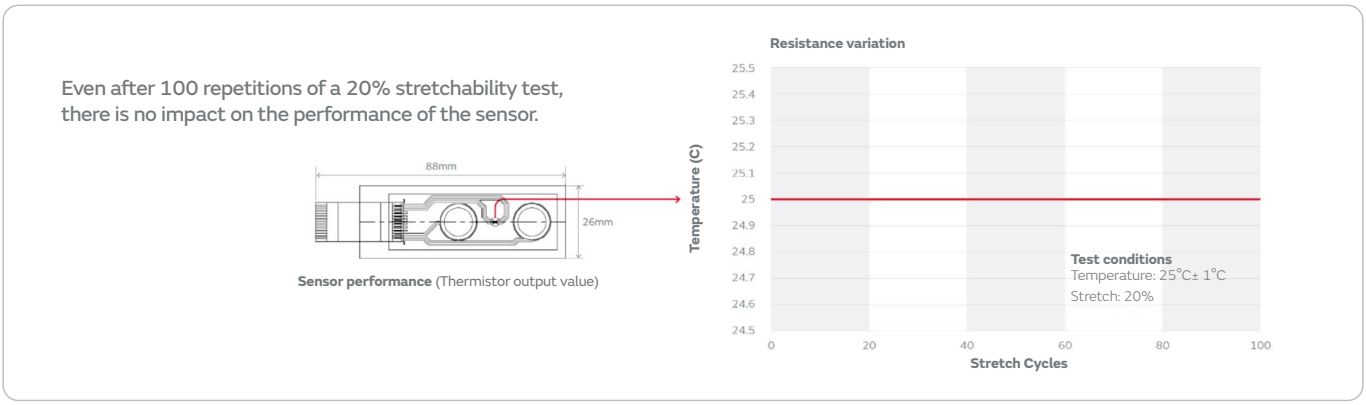

Figure 9 – Even after 100 stretch cycles, SESAS exhibits minimal resistance variation (Source: Murata)

3.3. Expanding The Abilities of Minimally Invasive Treatments

With invasive medical treatment, the need for precision and accuracy is heightened, and patient comfort and safety are the main concerns. It is essential for engineers to prioritize minimizing invasiveness, which involves focusing on miniaturization and the effective heat management of electronic components.

Murata's NeuroStone™ is a 3D-printed interconnected ceramic solution that is designed to shrink electronic assemblies in medical instruments, while simultaneously enhancing thermal management. NeuroStone™ leverages the inherent properties of ceramic materials and the precision of additive manufacturing (AM) to deposit ceramic, metal, and support materials via inkjet printing, forming precise shapes between 0.25mm x 0.25mm x 0.25mm to 5.0mm x 5.0mm x 1.0mm. The AM process allows complex undercut shapes to be produced using printed supporting material, which is then burned away during the co-fired process *(Figure 10)*.

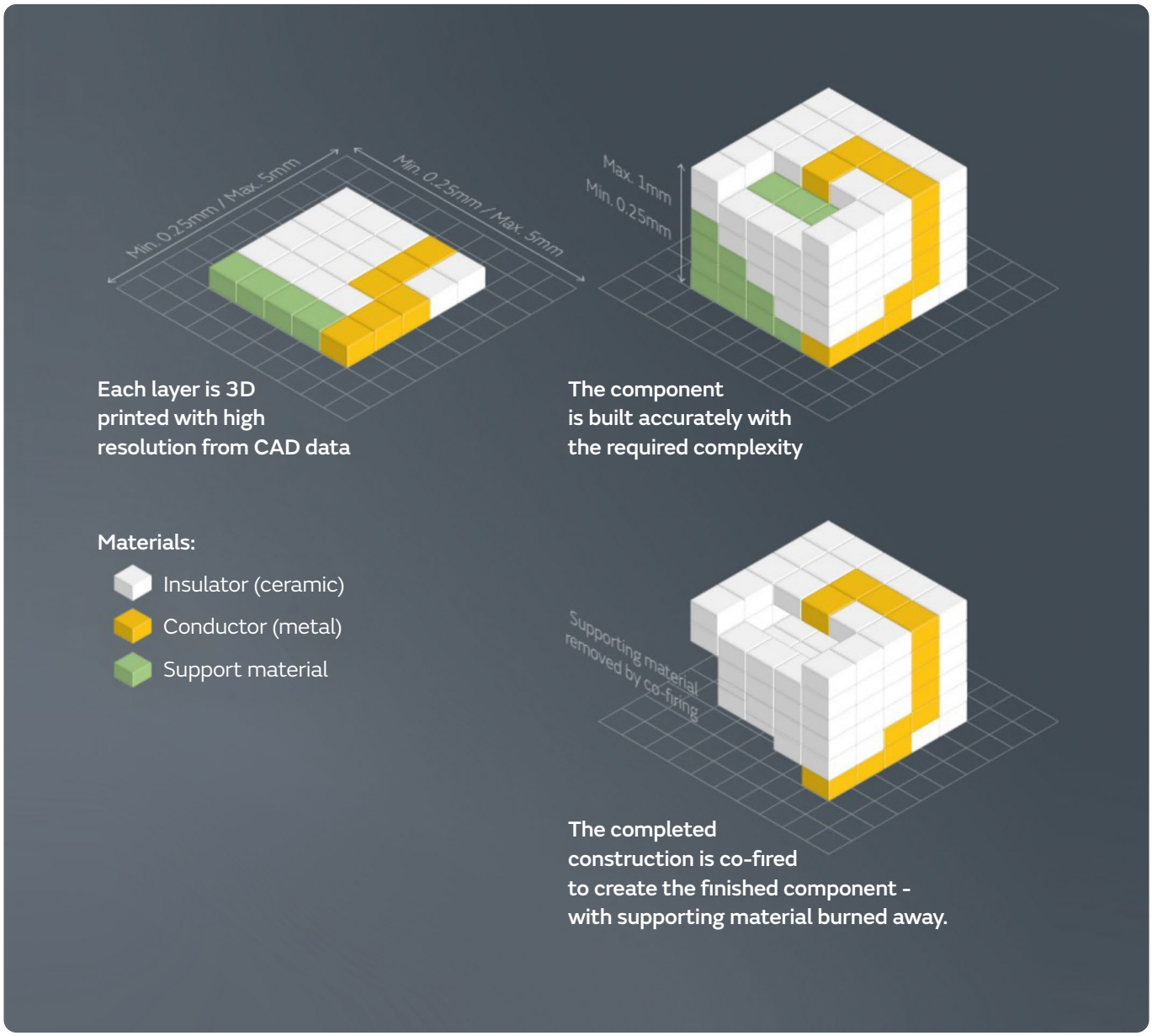

Figure 10 – 3D printing combined with co-firing helps to expand the shapes that can be created with NeuroStone™ (Source: Murata)

This innovative production process facilitates the simultaneous production of metallic conductors and ceramic insulators in a wide array of configurations, enabling the creation of intricately routed internal and surface wiring within the finished component. The speed of 3D printing and manufacturing directly from 3D CAD data allows for the rapid creation of designs expediting time to market, while also supporting small-scale and custom production, with the capacity to manufacture individual units.

Potential applications for NeuroStone™ include its use in minimally invasive medical devices, such as advanced endoscopes, catheters, implantable electronics, and diagnostic tools. For instance, NeuroStone™ has demonstrated its suitability for complex designs like the distal tip of a catheter. Here, its advanced 3D printing technology allows for the integration of a three-electrode sensor within a structure measuring only 0.8mm x 1.4mm *(Figure 11)*.

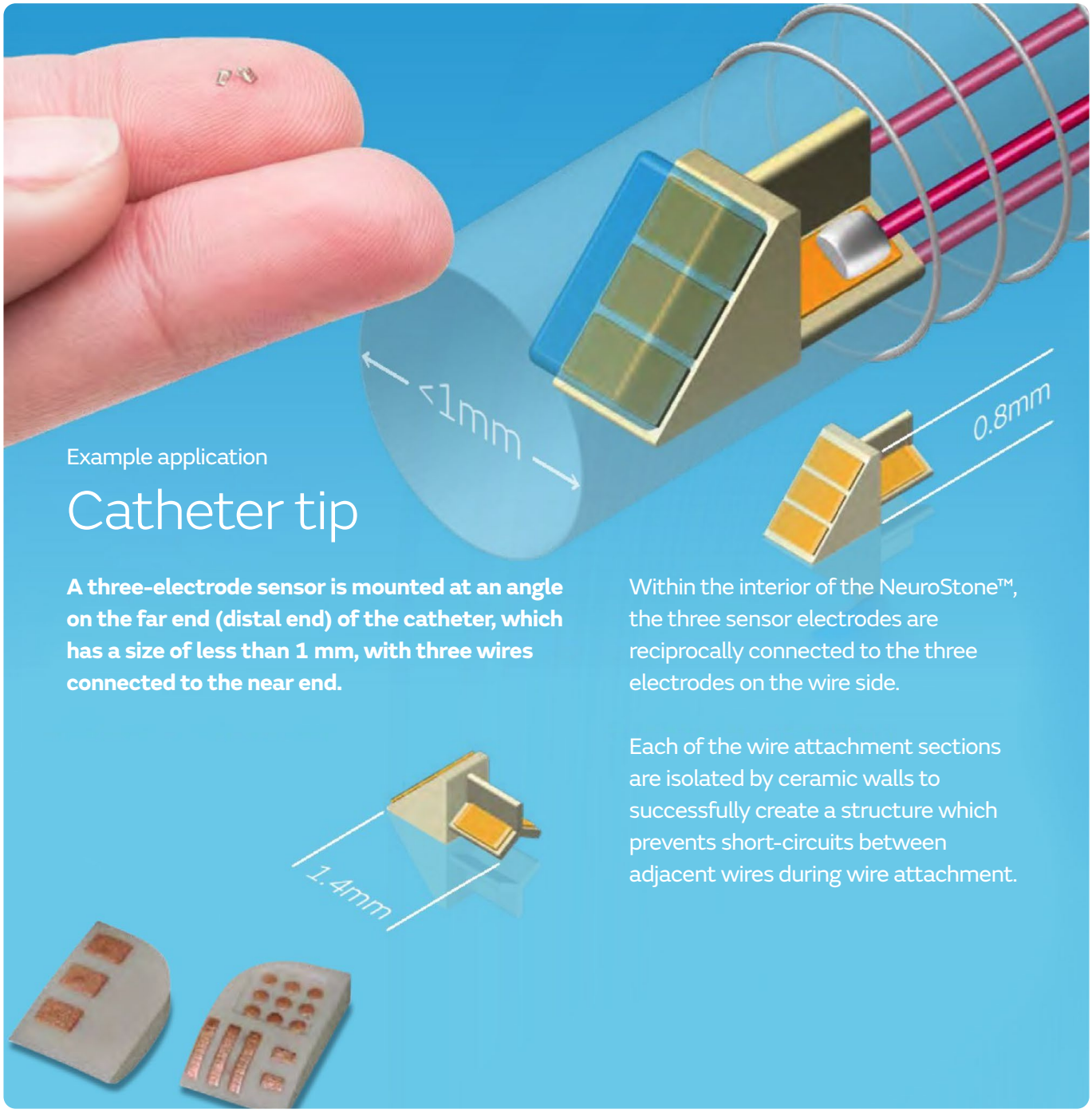

Figure 11 – Catheter tips are one of the many possible applications that can benefit from NeuroStone™ (Source: Murata)

Fabrication of this intricate structure using a single component would prove exceptionally challenging with alternative construction techniques, however, NeuroStone™ allows this with relative ease, and the ceramic wall assembly provides inherent electrical isolation between the electrodes and wire connections to prevent short circuits and ensure reliable performance. This innovation can help simplify the overall structure of a catheter, allowing for cost-effective manufacturing while maintaining the functionality needed for precise medical procedures.

NeuroStone's properties make it an ideal candidate for diagnostic devices, such as endoscopic cameras or capsule endoscopy systems, where compactness and precision are critical. The tighter integration of NeuroStone™ assemblies can facilitate the development of more compact and maneuverable endoscopy devices that are less invasive. Equally, the improvement can facilitate enhanced functionality, such as the compact integration of more complex circuits, increased illumination through high-performance LEDs enabled by superior thermal management, and larger channel space for medical instrumentation—all without increasing the endoscope's outer dimensions. For clinicians, this translates to improved usability and the ability to perform more advanced procedures with greater efficiency, while for patients, it means better treatment through less invasive procedures.

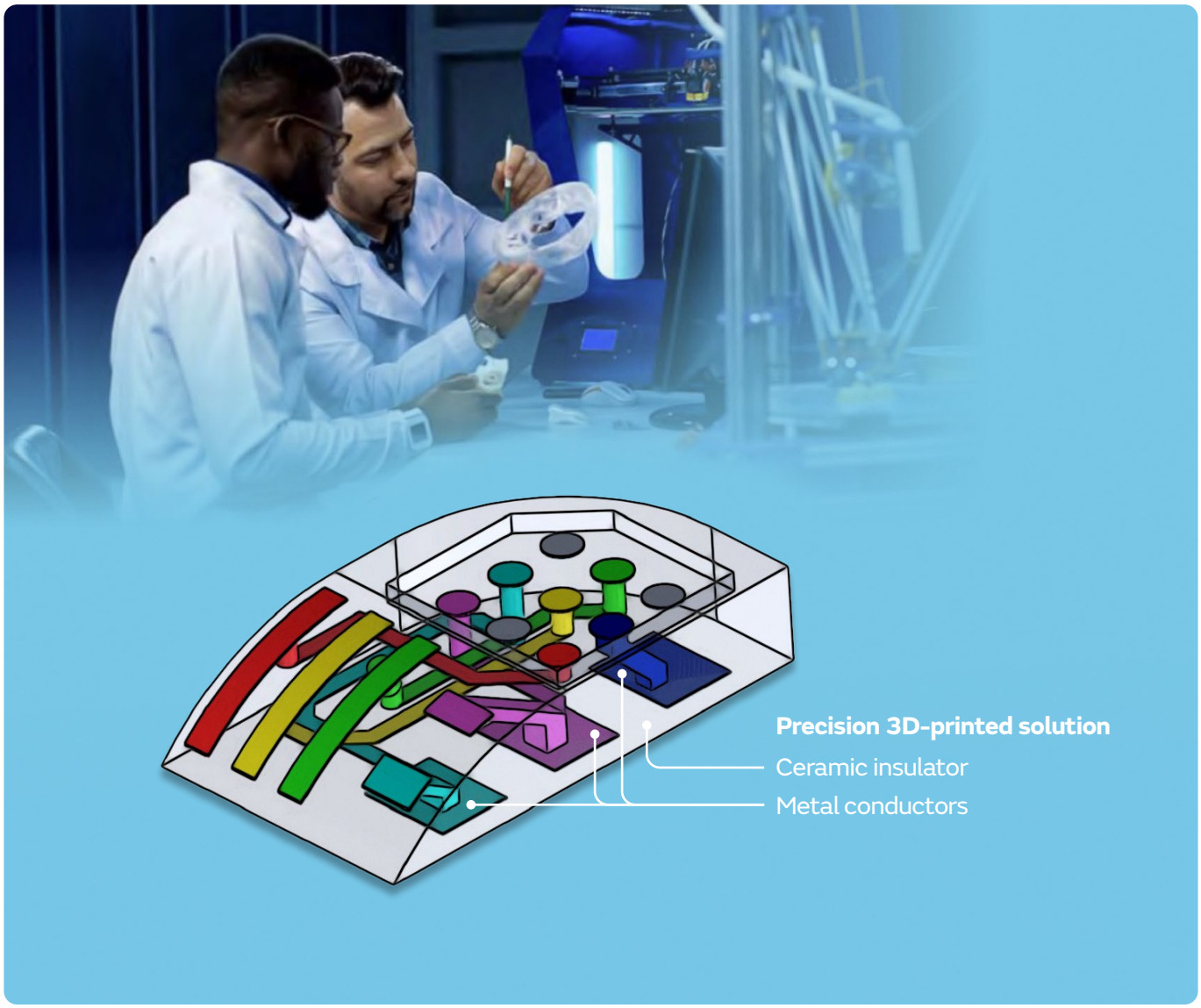

Figure 12 – NeuroStone™ helps to drive system integration and miniaturization through precision 3D printing (Source: Murata)

In addition to the device's dimensions, its thermal management is a critical feature, as delicate soft tissue may be easily damaged by heated components, such as LEDs. NeuroStone's ceramic composition also provides excellent heat sinking, helping to ensure invasive medical devices remain cool, and keeping the patient safe. The ceramic materials also ensure high reliability and heat resistance, essential for medical instruments that must endure the rigors of assembly temperatures and sterilization processes.

As the trend toward minimally invasive treatments continues to grow, NeuroStone™ provides an ideal platform for advancing medical technology. The combination of precision, customizability, and durability of NeuroStone™ can overcome many existing design and manufacturing challenges, accelerating the development of innovative devices that reduce the invasiveness of medical treatments, and helping to enhance patient comfort.

3.4. Unlocking a Diverse Range of Use Cases with Enhanced Traceability

Traceability is a cornerstone for efficient and safe healthcare delivery. Accurate tracking of pharmaceutical products, from suppliers of components like syringes to drug manufacturers, and extending through administration and disposal at the point of care, ensures operational efficiency and improves patient safety. This comprehensive oversight not only streamlines processes but also minimizes risks associated with product handling throughout the entire supply chain.

In healthcare, serialization offers a wide range of advantages, enabling greater transparency, accountability, and control throughout the supply chain. By assigning unique identifiers to products, serialization enhances traceability from manufacturing to administration. This ensures regulatory compliance, combats counterfeiting, reduces theft and diversion risks, and facilitates efficient inventory management. Additionally, serialization supports improved product use and waste reduction by providing detailed tracking data at every lifecycle stage.

Serialization of secondary packaging plays a critical role in operational efficiency and supply chain security. It improves inventory management by offering real-time visibility of stock levels while ensuring the accurate allocation of products where they are needed most. This simultaneously helps to ensure that waste is reduced, as serialized packaging simplifies identifying expired or unused medications before they become unusable.

Serialization also helps prevent counterfeit drugs from infiltrating the supply chain by enabling authentication at every step, as well as mitigating other risks such as theft or diversion into gray markets by allowing precise tracking of product movement.

At the primary container level, such as prefilled syringes (PFS), serialization addresses key challenges specific to production, handling, and regulatory compliance. The growing adoption of PFS is driven by its numerous advantages, including dosage accuracy, ease of use, and enhanced safety. However, this rise in usage necessitates greater integration among all stakeholders - manufacturers, distributors, healthcare providers, and regulators - to ensure these benefits are fully realized.

Primary container serialization ensures adherence to stringent quality standards during production by linking each unit to batch records for streamlined quality control processes. It also safeguards drug efficacy through proper handling and storage monitoring throughout transportation while ensuring compliance with regulatory requirements for unit-level traceability systems that track each syringe from manufacturing to administration.

3.4.1. Murata's RFID Solution

Murata's RFID solution for primary container serialization represents a novel approach based on trusted RFID technology, overcoming the shortfalls seen in standard solutions. Designed specifically for pre-filled syringes, vials, and cartridges, this ultra-compact solution seamlessly integrates into product caps, rigid needle shields (RNS), and connection mechanisms like Luer Lock systems, enabling full lifecycle tracking from production to end use. Integrating Murata's class-smallest RFID tag, which includes an integrated antenna, directly into the RNS or Luer lock system during the PFS production process, offers several benefits. This approach, as illustrated in *Figure 13,* improves workflow efficiency, maintains the clarity of visual inspections, and eliminates contamination risks during drug-filling operations.

Figure 13 – The RFID tags can be integrated into medical caps at the point of manufacturing (Source: Murata)

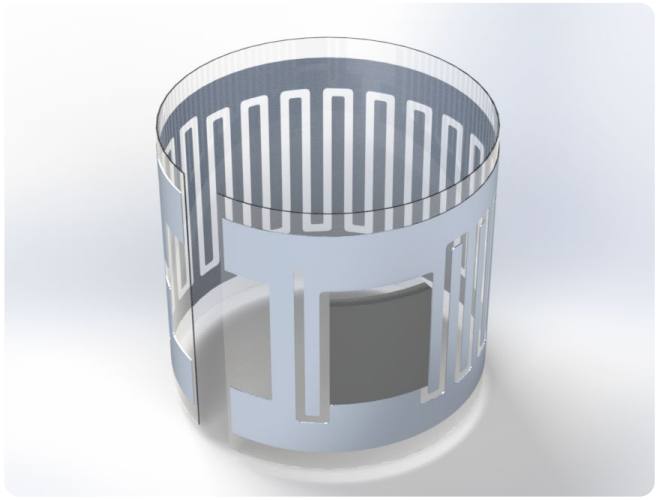

Figure 14 - Murata's RFID inlay, powered by Coupling module technology (Source: Murata)

Alternatively, using a tiny inlay (20 mm x 5 mm) powered by Murata's Coupling module technology, featuring a matching and resonance circuit, achieves the same advantages *(Figure 14).*

One of the standout features of the Murata RFID solution for primary container serialization is its ability to eliminate RFID blind spots. As a leading innovator in RF systems, Murata has developed a compact yet powerful RFID antenna, resulting in a small, robust, high-performance wraparound RFID label. This design ensures complete 360° readability and accurate identification of tagged items, regardless of their orientation, even in high-speed and high-volume applications. *(Figure 15).*

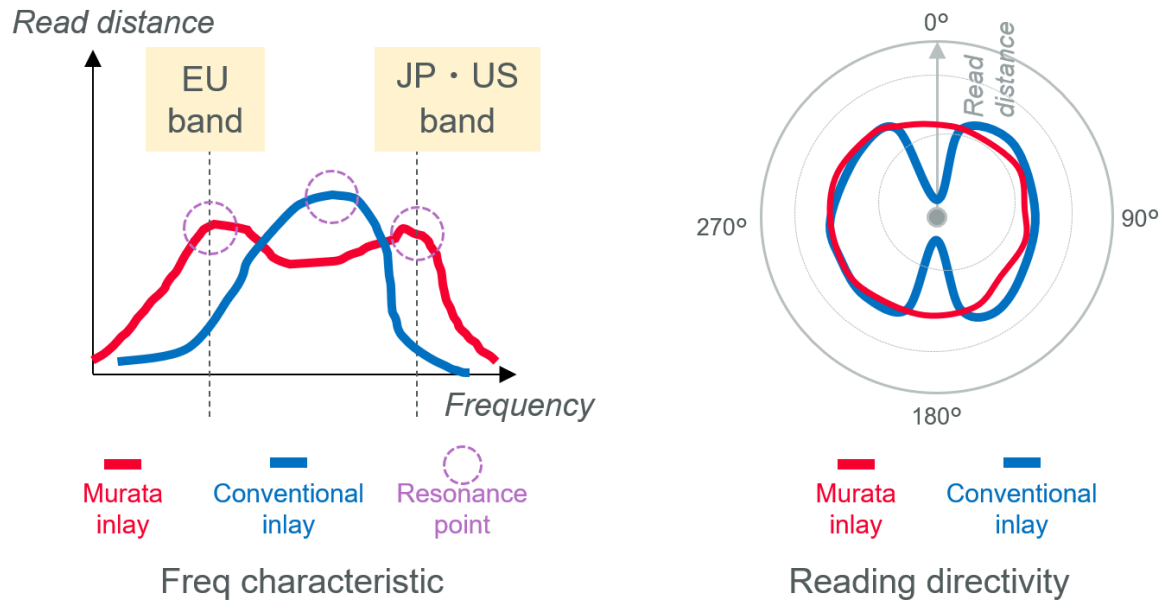

Figure 15 – Unlike traditional RFID technology, Murata tags have no blind spots (Source: Murata)

Another notable advantage of Murata's RFID inlay is its dual resonance points, which provide significant operational flexibility and efficiency. In contrast to other manufacturers' inlays, which possess a single resonance point, necessitating the purchase of two distinct RFID-enabled PFS types by pharmaceutical companies for EU (860 MHz) and US/Japan (920 MHz) regions, Murata's dual resonance points enable a single PFS incorporating our RFID inlay to achieve universal readability across both frequency ranges.

This greatly simplifies logistics for pharmaceutical companies by eliminating the need for region-specific inventory management while ensuring that PFS products can be read accurately and reliably anywhere in the world, significantly reducing complexity and improving supply chain efficiency.

The tag's unique design enables precise detection of over 600 units per minute through a dynamic single reading. Within production settings, this enables high-throughput and accurate real-time identification, even at peak production rates. Each tag provides item-level serialization, providing accurate tracing of individual syringes, vials, or cartridges, and supporting batch segregation should a defect be found in the aftermarket. Unlike conventional QR codes that require a clear line of sight for scanning and can interfere with PFS's visual inspection, RFID tags provide a more efficient and reliable alternative. By embedding the Unique Device Identification (UDI) in the RNS or Luer Lock system, all relevant product information can be accessed or updated directly from the Enterprise Resource Planning (ERP) system. This approach reduces the risk of manual input errors and eliminates the need for retrofit labels, which may pose contamination risks.

This solution is particularly relevant for high-cost medications used in treating rare diseases, cancers, genetic disorders, and chronic viral infections, where the financial impact of yield loss is most significant. However, the advantages of Murata's RFID solution can extend beyond medical manufacturing and logistics. In aftermarket applications, RFID tags can provide users with enhanced information, including access to usage instructions and support for counterfeit drug prevention. For instance, in connected ecosystems like smart rechargeable insulin injectors, the RFID tag can facilitate the transmission of usage data to the cloud. This enables real-time patient monitoring and improves the overall quality of care.

The Murata RFID solution for primary container serialization showcases how innovative technology can address complex challenges in modern healthcare. By accurately tracking items, enhancing production and logistics processes, improving waste management, and strengthening product authentication. This solution helps institutions comply with regulations such as FDA 21 CFR 610.14, and ultimately, it promotes better patient outcomes and supports a more sustainable healthcare environment.

3.4.2. Murata RFID Example Applications

The implementation of RFID technology in primary container serialization can be especially effective in delivering a positive return on investment by streamlining the incoming inspection of prefilled syringes (PFS) and monitoring individual sample syringes during quality control.

Case 1: Improved Incoming Inspection of Prefilled Syringes

RFID serialization, combined with shared quality control (QC) data from PFS manufacturers, transforms the incoming inspection process by:

- Enabling faster, automated verification of each syringe, reducing inspection time.
- Allowing complete unit-level inspection, ensuring comprehensive quality checks.
- Integrating QC data to detect defects early, preventing production disruptions.
- Providing digital QC records for enhanced traceability and compliance with regulatory standards.
- Reducing quarantine time and preventing line stops by identifying non-conforming syringes early.

Overall, RFID serialization in incoming inspections leads to more efficient operations, defect-free syringes, robust traceability, avoidance of costly delays, and significant cost savings in labor and waste prevention.

Case 2: Monitoring the Excursion Time of Individual Sample Syringes During Quality Control

Using RFID serialization to monitor the Time Out of Refrigeration (ToR) for individual syringes during QC processes offers benefits such as:

- Precise temperature monitoring for each syringe, allowing targeted rejection of non-compliant units.
- Waste reduction by avoiding bulk rejection and minimizing product loss.
- Cost savings by reducing financial impact and lowering inspection costs.
- Improved quality assurance and compliance with regulatory standards for temperature-sensitive medications.
- Operational efficiency through streamlined processes and pre-packaging validation.

RFID serialization for ToR monitoring ensures precise control over product integrity, minimizes waste, reduces costs, and maintains compliance, enhancing supply chain performance and patient safety.

3.5. Increasing Patient Comfort and Service Delivery with Microblower Technology

Patient comfort is paramount when designing healthcare technologies, especially when noise, vibrations, or size limitations could negatively affect the patient. Air pumps commonly found in medical equipment, such as sphygmomanometers or jet injectors, often create significant noise and vibration, which can be disruptive in quiet environments or distressing for patients undergoing prolonged treatments. Furthermore, the pulsations intrinsic to conventional mechanical pump designs may introduce performance variability, reducing the accuracy of air or fluid delivery and thus compromising treatment efficacy. Murata's innovative piezoelectric diaphragm Microblowers offer a high-performing, compact, and quiet solution, capable of overcoming these challenges and increasing patient comfort.

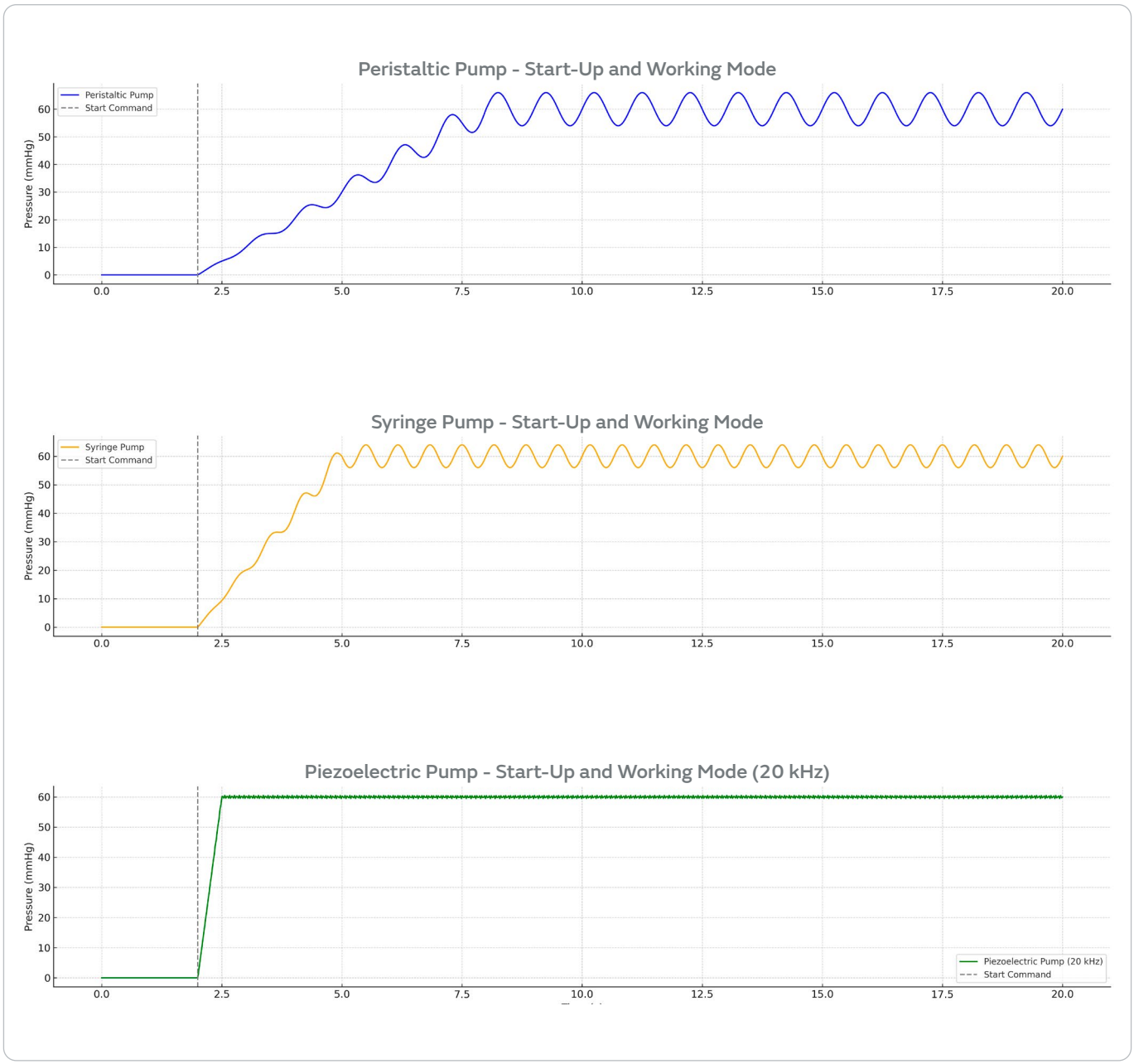

Figure 16 – Microblowers offer a significant reduction in pulsations compared to diaphragm pumps with motors (Source: Murata)

Operating on the principle of ultrasonic vibrations generated by a piezoelectric element, the Microblowers vibrate in the ultrasonic band (20 kHz or more), so they are inaudible to humans. This makes them ideal for use in environments where quiet operation is essential, such as neonatal wards, sleep therapy settings, or at-home medical devices.

The devices are able to achieve high pressure and flow rates despite their small size, and a wide array of models are available to cater to diverse applications with varying discharge/suction pressures and flow rates *(Figure 17)*.

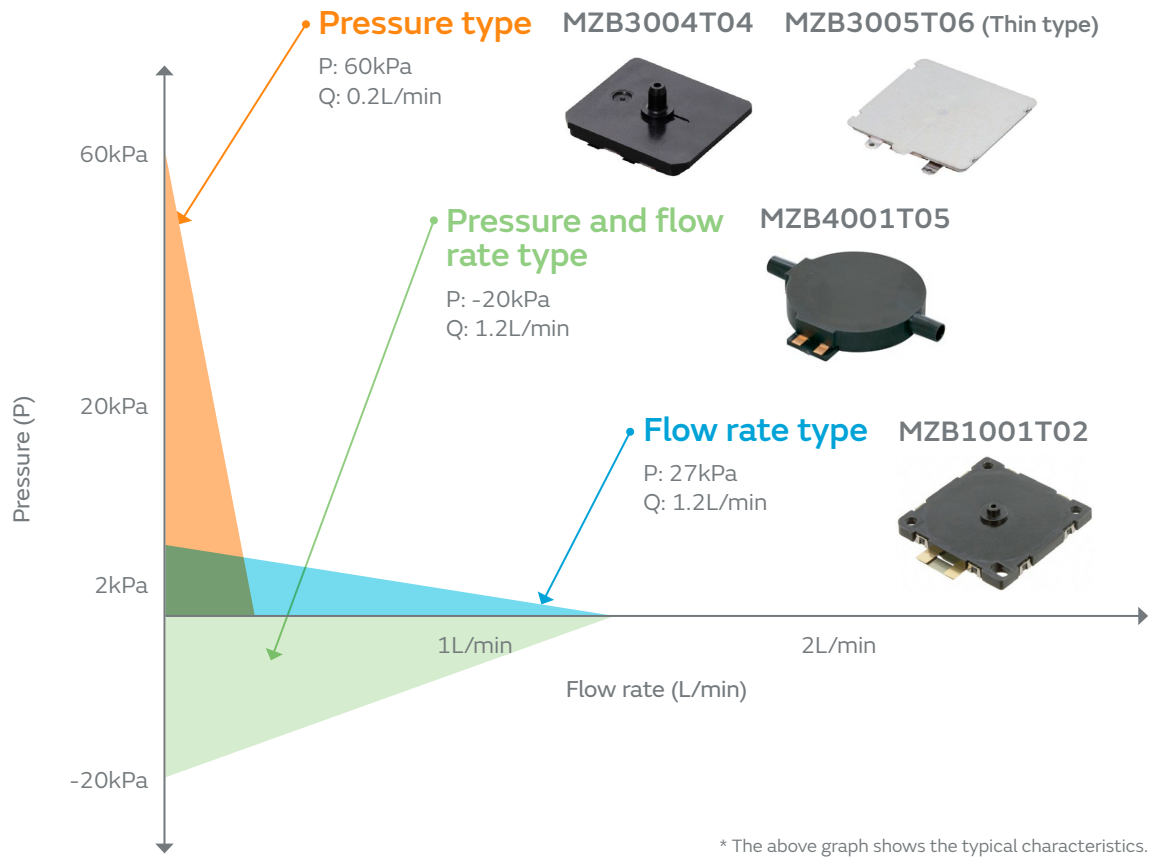

Figure 17 – Murata provides a range of Microblowers to suit several applications depending on their flow rate or pressure requirements (Source: Murata)

The high-frequency piezoelectric elements facilitate rapid response and precise modulation of stable airflow due to the material's instantaneous amplitude change in response to voltage fluctuations. Consequently, pump characteristics are readily controlled by adjusting the input voltage to the oscillation circuit. This operation not only optimizes performance but also allows for easy integration and precise tuning to meet specific application requirements *(Figure 18)*.

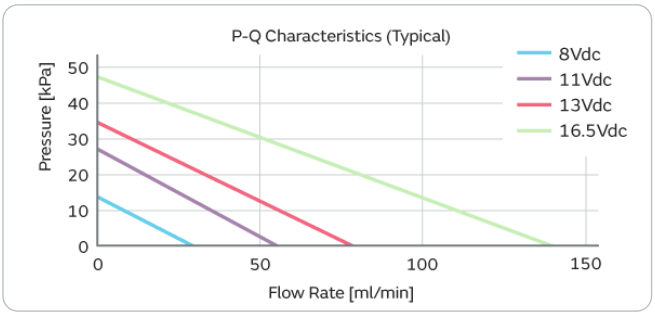

Figure 18 – Microblowers are modulated through simple voltage input (Source: Murata)

Typically measuring approximately 20 mm in size, with the thinnest model just 2.3 mm in depth, the Microblowers' lightweight and slim designs also allow them to be integrated into small or wearable devices where space weight and patient comfort are critical considerations.

Unlike conventional motor-driven pumps, the piezoelectric diaphragm's motion produces a continuous flow of air without pulsation, enabling smoother and more consistent air delivery.

The pulsation-free operation is particularly valuable in medical applications requiring precise air control, such as slow forced air injections used in cancer treatments, and by ensuring a steady flow, the Microblowers improve the accuracy of drug administration. The device's smooth airflow makes it suitable for other air-moving applications, including flushing liquids out of cavities, negative pressure therapies, breath pumps, and even sleep apnea devices, which require smooth and quiet operation to enhance both patient experience and device efficacy. Furthermore, higher flow rates and pressures are achievable by connecting the devices in parallel or series *(Figure 19)*, thus supporting applications with more technical requirements beyond a single pump, and beyond positive pressure applications, the devices accommodate negative pressure (suction) applications.

Murata's piezoelectric diaphragm Microblowers represents a fundamental shift in medical air pump technology, replacing traditional mechanical motors with quieter, smoother piezoelectric devices, reflecting a commitment to patient-centric design. The compact, quiet, and pulsation-free operation helps engineers address critical challenges in medical device engineering, offering a versatile and reliable solution that enhances patient comfort.

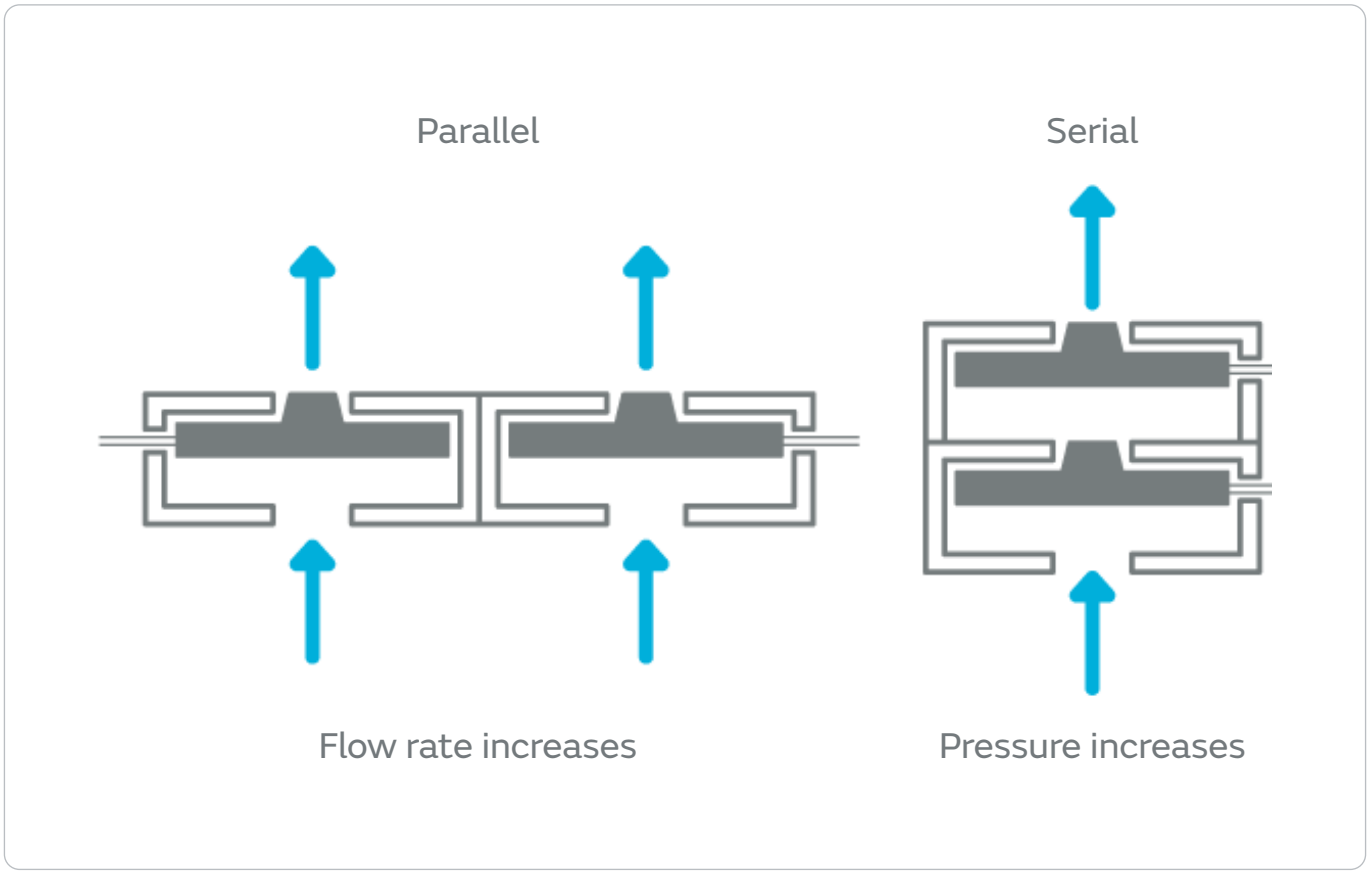

Figure 19 – The Microblowers can be combined in parallel or series to increase flow or pressure (Source: Murata)

3.6. A Broad Range of Wellness Components

In addition to its innovative wellness solutions, Murata offers a broad range of electronic components enabling engineers to develop more intelligent, compact, and energy-efficient medical devices and personal healthcare products. The components include a broad selection of wireless connectivity modules supporting Bluetooth, Wi-Fi, and LPWA protocols, as well as dedicated Ultra-Wideband (UWB) devices for secure and precise distance measurement applications.

The Type 2EA, for instance, supports 2.4 GHz, 5 GHz and 6 GHz Wi-Fi, as well as Bluetooth 5, achieving data rates as high as 1.2Gbps for Wi-Fi and 3 Mbps for Bluetooth. The module's advanced chipset uses innovative hardware and algorithms to provide power-efficient, high-performance connectivity for smart IoT wellness devices, including those with advanced video, audio, and virtual reality features *(Figure 20)*.

Alternatively, the Type 2EG offers just ultra-low-power Bluetooth® 5.2 connectivity, supporting both integrated and external antenna configurations and coming in a compact 7.0 x 7.4 x 1.0 mm package for seamless physical integration. The device's advanced peripheral interfaces, integrated IoT cybersecurity platform, and powerful onboard microcontroller unit (MCU) make it well suited for connected IoT edge medical devices that require reliable and secure connectivity.

Core to Murata's component offering is its broad portfolio of cutting-edge passive components, which are shaped by Murata's extensive knowledge of miniaturization and material science that push the limits of performance and packaging, whilst also ensuring reliability. The extensive portfolio includes components such as thermistors, crystal timing units, inductors, filters, and the market's most abundant lineup of ceramic capacitors, that all meet the latest technical demands in wellness electronics. For example, the LF Series chip multilayer LC filters are used to extract or attenuate a specific frequency band in medical audio devices like hearing aids. Characterized by their compact packaging, the low-temperature co-fired ceramic (LTCC) components are available in a wide number of variants, with each tailored to either block or pass a designated frequency band.

Also available from Murata are power electronic components designed to address a wide range of power levels. This portfolio includes compact components such as silver oxide batteries, which are designed for extended operation in low-power wellness devices like medical monitoring equipment and wearables. It also covers isolated DC-DC converter modules, non-isolated DC-DC converters, AC-DC converters, and isolated gate drive power modules that are suited to fixed medical equipment such as medical imaging apparatus, where efficiency and reliability are of paramount importance.

Regardless of your wellness application, Murata has a wide range of components that can help to push your design's functionality, reliability, integration, and performance.

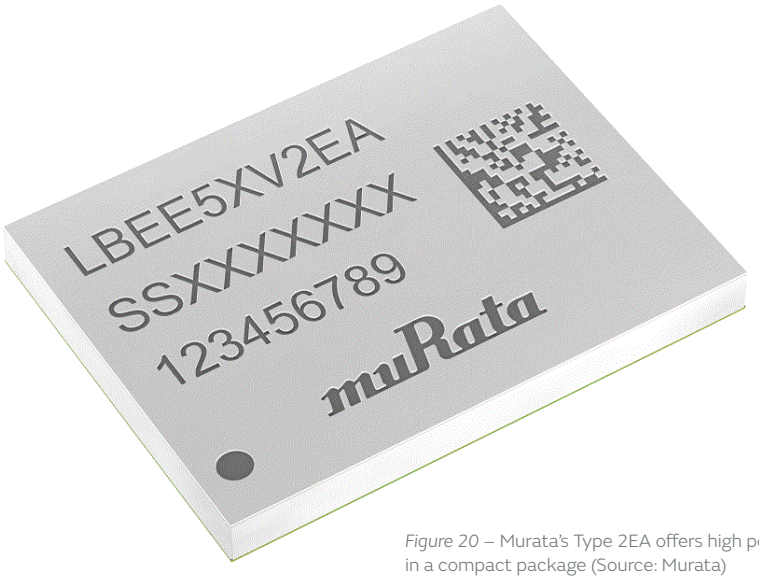

Figure 20 – Murata's Type 2EA offers high performance in a compact package (Source: Murata)

4. Conclusion: Empowering Future Healthcare Technology

The global wellness industry is undergoing rapid transformation, shaped by demands for sustainability, personalized care, and operational efficiency. This evolution presents immense opportunities for innovation, but it also brings technical challenges, from miniaturization to ensuring compliance with stringent healthcare standards. Murata's system-level expertise, combined with its diverse portfolio of solutions, positions the company as a critical enabler of this transformation capable of supporting medical designers in driving wellness innovation capable of improving healthcare delivery.

Figure 21 – Example wellness devices that can be enhanced through Murata's technology. (Source: Murata)

By addressing critical challenges such as patient comfort, traceability, and resource efficiency, Murata's latest solutions are designed to help engineers and medical product designers to redefine wellness applications. From stretchable electronics like SESAS, enabling advanced patient monitoring, to NeuroStone's 3D-printed ceramic innovations revolutionizing minimally invasive procedures, and the piezoelectric Microblower enhancing patient-focused device design, the technologies are not just about incremental improvements – they represent a reimagining of how care is delivered and experienced.

The company also provides a broad range of electronic components that merge integration, performance, and reliability, assisting engineers and product designers in the development of wellness devices. With the industry's evolution, the need for such sophisticated components is set to increase and Murata's portfolio is poised to meet this growing demand, ensuring its role as a supportive partner in the industry's progress.

Murata is dedicated to supporting the engineers and product designers who are shaping the future of wellness, to improve patient outcomes and foster a more sustainable healthcare system. Through collaboration and a shared vision for innovation, together we can create the wellness ecosystem of tomorrow that is capable of extending and enhancing care for the benefit of us all.

More Information

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Murata | www.murata.com

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