White Paper

The evolution of modern pressure sensors

From individual components to a continuously evolving sensor platform

Abstract

Pressure sensors today are far more than mere transducers – they must simultaneously meet a variety of requirements. On the one hand, the demands placed on sensors in terms of measurement accuracy, speed, diagnostics, safety and susceptibility to interference are constantly increasing. At the same time, development costs need to be reduced. Furthermore, equipment manufacturers face the challenge of striving for the longest possible product life cycles in an environment of rapidly changing markets. This white paper explains why, in addition to individual components, the underlying sensor platform is becoming increasingly important, and how continuously evolving platforms can support long-term product strategies.

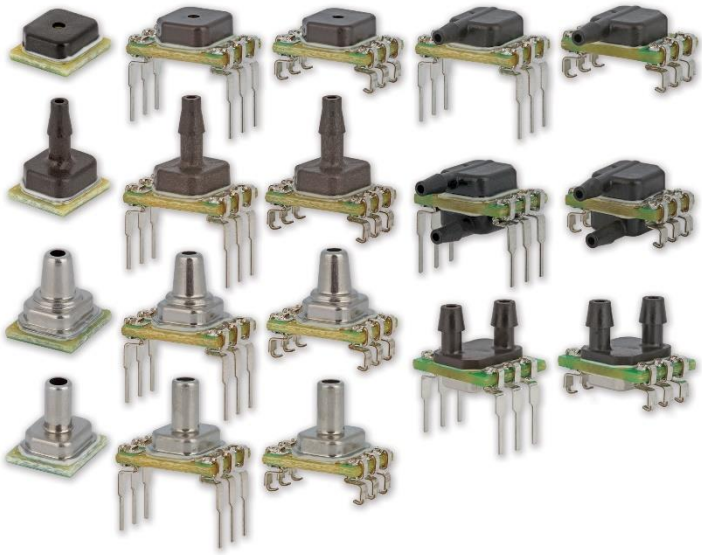
Introduction

Pressure sensors have played a key role in medical, industrial and building services applications for many years: measuring pressure precisely and reliably. This core function remains unchanged. However, the environment in which pressure sensors are used is changing increasingly.

Devices are becoming smarter and more interconnected, new functions are being added, and the demands on accuracy, speed, diagnostics, safety and robustness are rising. At the same time, once developed, products are expected to remain on the market for as long as possible, and existing investment in development must be protected.

Consequently, the perspective on selecting a pressure sensor is also changing. Alongside the question of which sensor meets today's technical requirements, the technological basis that supports the further development of future product generations is becoming increasingly important.

This white paper examines this development, from the sensor element to the sensor platform, and demonstrates why continuous platform development is becoming a key factor in long-term product strategies.



1. It all starts with the sensor element

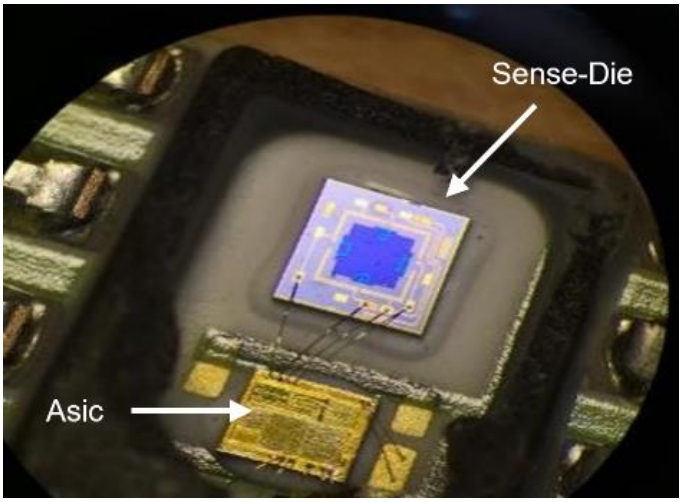
The foundation for precision, stability and reliability

At the heart of every pressure sensor lies the actual sensor element (the sense die). It converts the applied pressure into an electrical signal, thereby forming the physical basis for all subsequent signal processing. A good sense die exhibits the following characteristics:

- High sensitivity — small changes in pressure must be reliably detected
- Good repeatability — the same pressure should always produce the same result
- Low drift / high long-term stability — the measurement behaviour should change as little as possible over the years
- Good temperature stability — temperature fluctuations should have as little effect as possible on the measurement result, or must be reliably compensable
- High mechanical robustness — the Sense-Die must reliably withstand pressure cycles, overpressure and the demands of the respective application

The mechanical design must be modular and scalable, so that different configurations are possible. For small pressure ranges, the Sense-Die is designed to be very thin in order to reliably detect even the slightest changes in pressure. As the pressure range increases, the mechanical design changes and more robust versions are used.

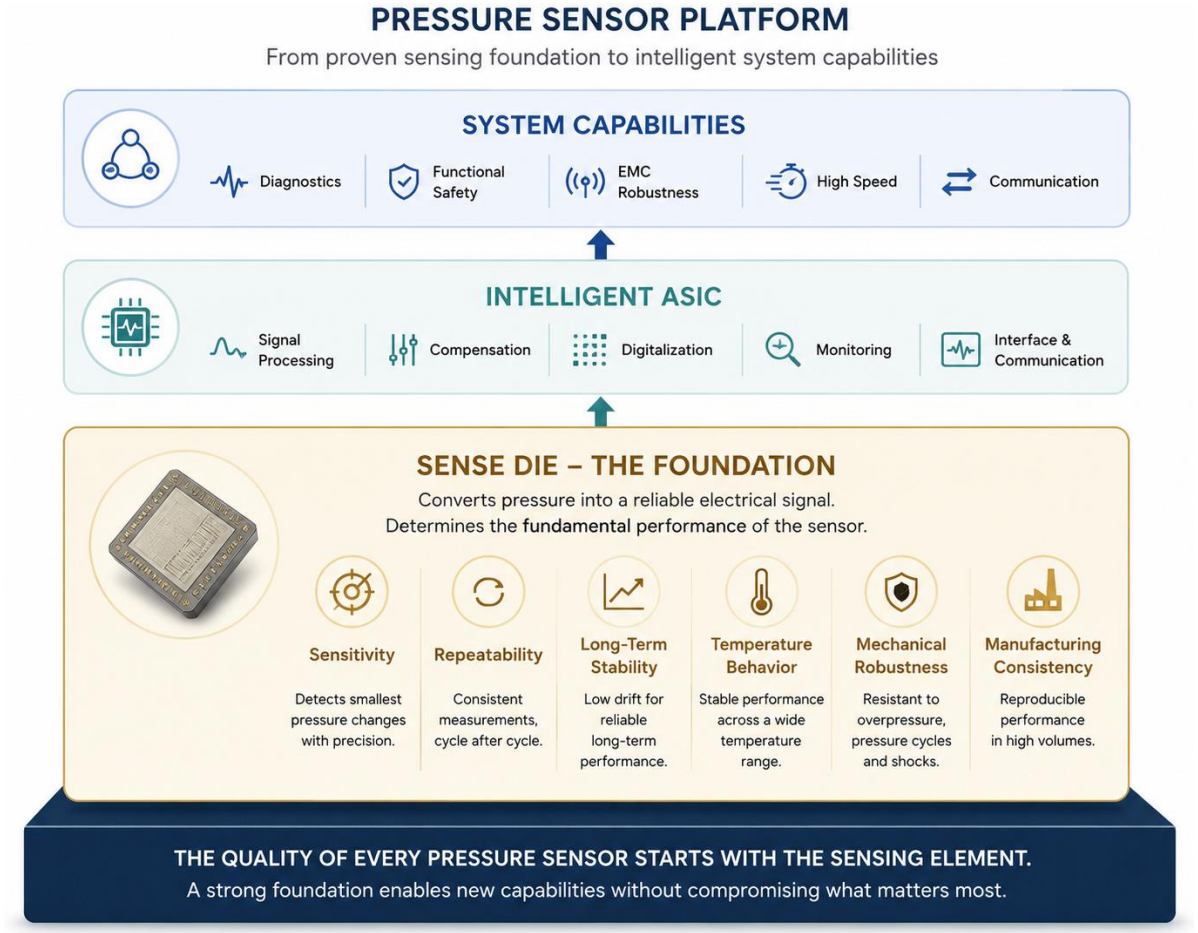
Practical example: Modern pressure sensor platforms can cover a very wide pressure range from ±2.5 mbar to 20 bar – with a permissible overpressure of up to 30 bar and a burst pressure of up to 40–60 bar. This wide pressure range is achieved using several sensor die designs (including different diaphragm thicknesses).



It is not just the individual sensor that has to be of high quality. The sense die and the entire mechanical assembly must enable reproducible manufacturing quality – so that consistent performance and quality can be maintained over many years, even when producing large quantities.

Modern electronics amplify, compensate for and digitise the raw signal from the sense die, and analyse it intelligently. They can enable additional functions such as diagnostics, monitoring or safety mechanisms. However, the quality of the underlying measurement signal remains the foundation.

A high-performance pressure sensor platform therefore begins with a stable and reliable sensing die. Building on this foundation, modern electronics can incorporate additional performance features, intelligence and functions without having to reinvent the tried-and-tested physical basis.



2. The requirements for pressure sensors are changing

Modern pressure sensor technology now goes far beyond the mere measurement of pressure

Pressure sensors are now an integral part of numerous medical, industrial and building services systems. Their fundamental function remains the same: to measure pressure accurately and reliably.

However, the demands placed on the sensor and its role within the overall system are evolving rapidly.

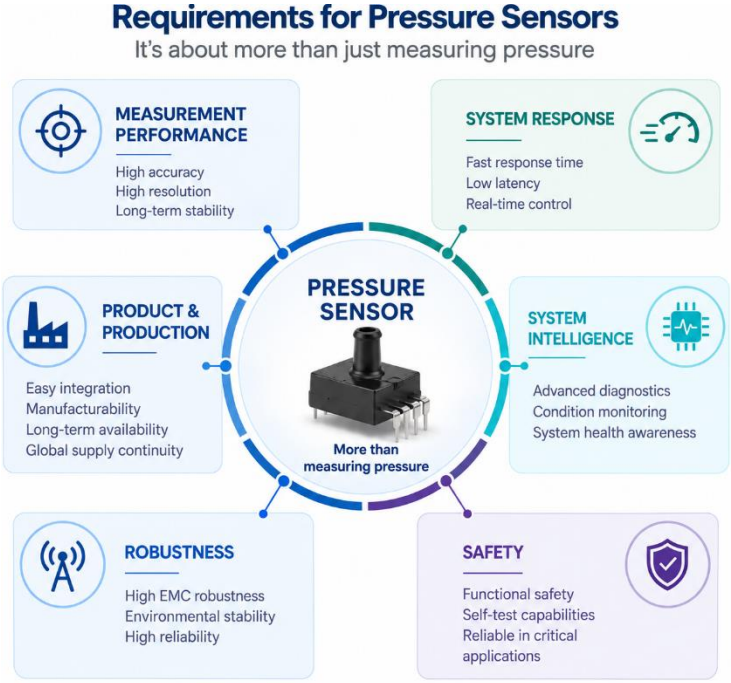
Modern devices are becoming smarter, more automated and increasingly connected. At the same time, expectations are rising in terms of measurement accuracy, response and transmission speeds, diagnostic capabilities, functional safety and a high level of electromagnetic compatibility (EMC) – in everyday technical use: a high level of immunity to interference.

A **pressure sensor** therefore no longer simply provides a single measured value. Its performance has a significant impact on control, system monitoring, safety and the functions available on a device.

At the same time, the framework conditions for **product development** are also changing. Development resources are limited, regulatory requirements are increasing, and production processes must operate efficiently and reliably. At the same time, manufacturers expect the components they use to be **available in the long term**.

The protection of **investment in development** is also becoming increasingly important: once development work has been completed, the results should be put to good use for as long as possible.

There is a need for sensor platforms that combine high measurement accuracy with intelligent functions, reliable integration and a long-term outlook, thereby meeting today's requirements whilst also supporting future product developments.



3. Different perspectives. One sensor platform.

Different requirements within the organisation. A single platform must bring them all together

The requirements for a pressure sensor vary depending on the task and the perspective within a company.

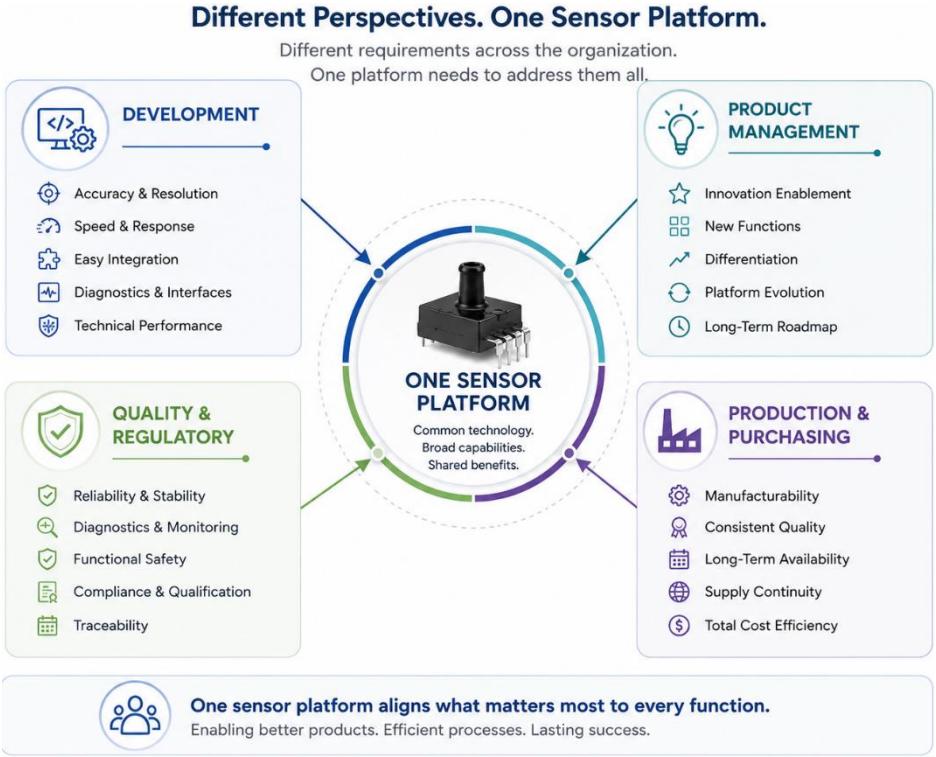
Whilst measurement accuracy, integration and technical functions are the key factors in product **development**, product management also considers opportunities for innovation, product differentiation and the long-term **development of a product**.

Quality management, on the other hand, focuses on reliability, stability, diagnostic capabilities and safety.

For **production and procurement**, alongside efficient processing, reproducible quality, long-term availability and a reliable supply chain play a particularly important role.

These **different perspectives come together in a single product**. The choice of pressure sensor therefore affects not only the quality of the measurement, but also development costs, optimised production processes, future product generations and, ultimately, the long-term competitiveness of a device.

A modern sensor platform must bring these differing requirements together. It provides a common technical foundation on which developers can create high-performance and innovative solutions, product managers can introduce new features, whilst quality, production and procurement teams can rely on a stable platform that will remain available in the long term.



Bringing together different perspectives is the first step.

However, this presents a further challenge: products and devices are expected to remain on the market for many years, whilst technologies and requirements are constantly changing.

4. Long product life cycles. Rapidly changing markets.

Keeping tried-and-tested products up to date as technologies and requirements evolve

Many products in the medical technology, industrial and building automation sectors are designed to remain on the market for a long time. Development, qualification and certification are time-consuming and costly. Manufacturers are therefore keen to continue using existing platforms successfully for as long as possible.

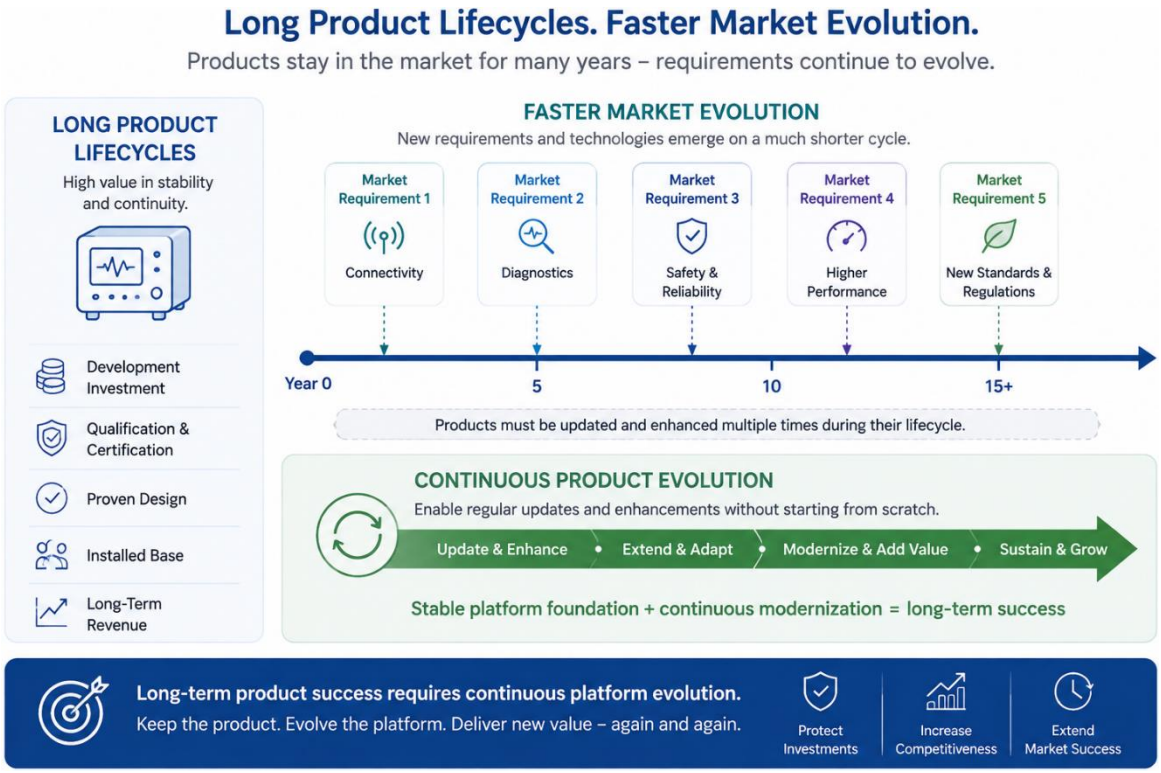
At the same time, the demands of end markets are evolving at a much faster pace. New functions, communication standards, regulatory requirements, stricter safety standards and rising expectations of systems mean that existing products need to be regularly updated.

This creates a tension: **The product is intended to remain on the market for a long time, yet the technology used in it must be able to evolve continuously**.

A complete redesign is rarely the preferred solution. It ties up development resources, increases the training burden and may affect existing certifications or production processes. **There is therefore a need for platforms** that combine long-term stability with continuous development.

When selecting a pressure sensor, this means that it is not just the current specification that matters. Equally important is the question of whether the platform used can accommodate future requirements and offers a reliable migration path for future product generations.

Long-term product success is achieved where stability and continuous innovation are not seen as mutually exclusive, but are instead firmly embedded together within a platform strategy.



5. From component to platform

When selecting sensors today, it is important to bear in mind the next generation of products

Traditionally, a pressure sensor is selected primarily on the basis of the requirements of a specific application: pressure range, accuracy, output signal, response time, design and cost are the key factors in the decision. These criteria remain important.

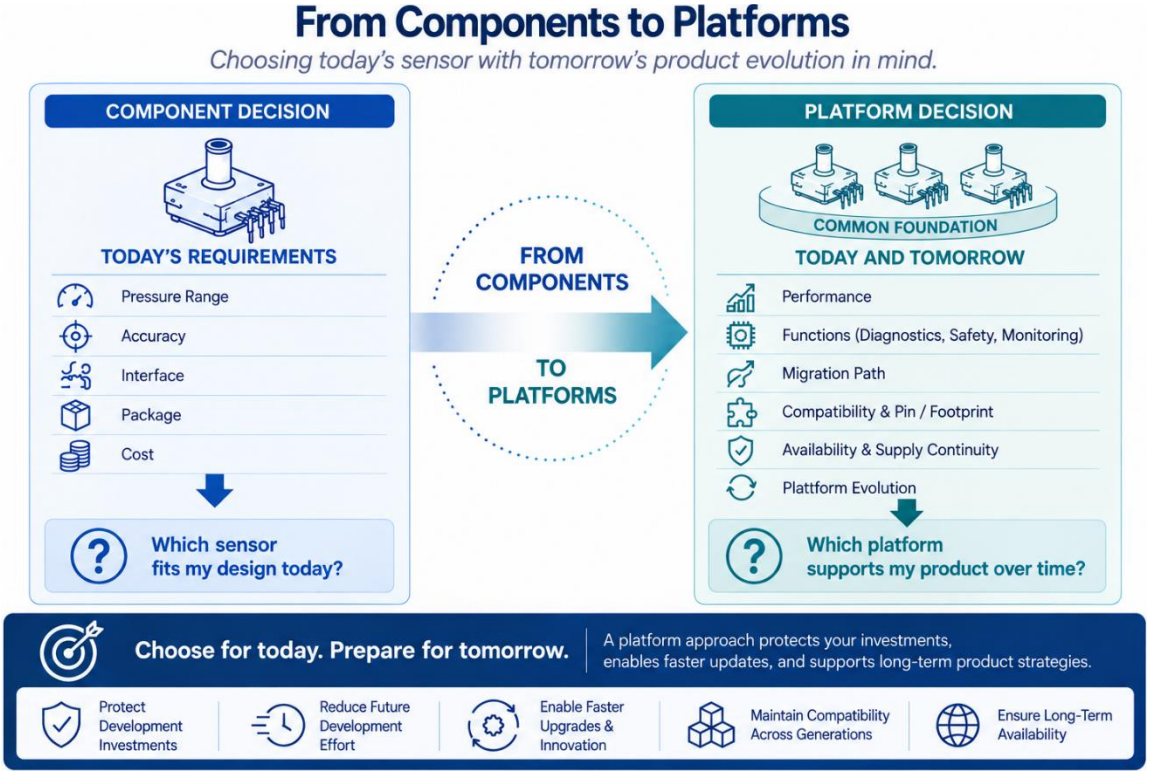
However, with longer product life cycles and rapidly changing requirements, another perspective is becoming increasingly important.

The question is therefore no longer simply: **Which sensor meets the requirements of our current design?** Increasingly, the question is also: **Which technological platform offers us the flexibility we need for the further development of our product?**

This broadens the perspective from the individual component to the underlying platform. In addition to current technical specifications, future performance reserves, additional functions, a wide range of variants, long-term availability and further development across several product generations are thus becoming increasingly important.

A platform decision therefore does not merely take the current state of development into account. Right from the selection stage, it considers how products and their requirements may change in the future.

The right sensor platform not only meets the requirements of today's design; it also leaves scope for its future development.



6. More than just pressure measurement

Modern pressure sensors are becoming intelligent components within the overall system

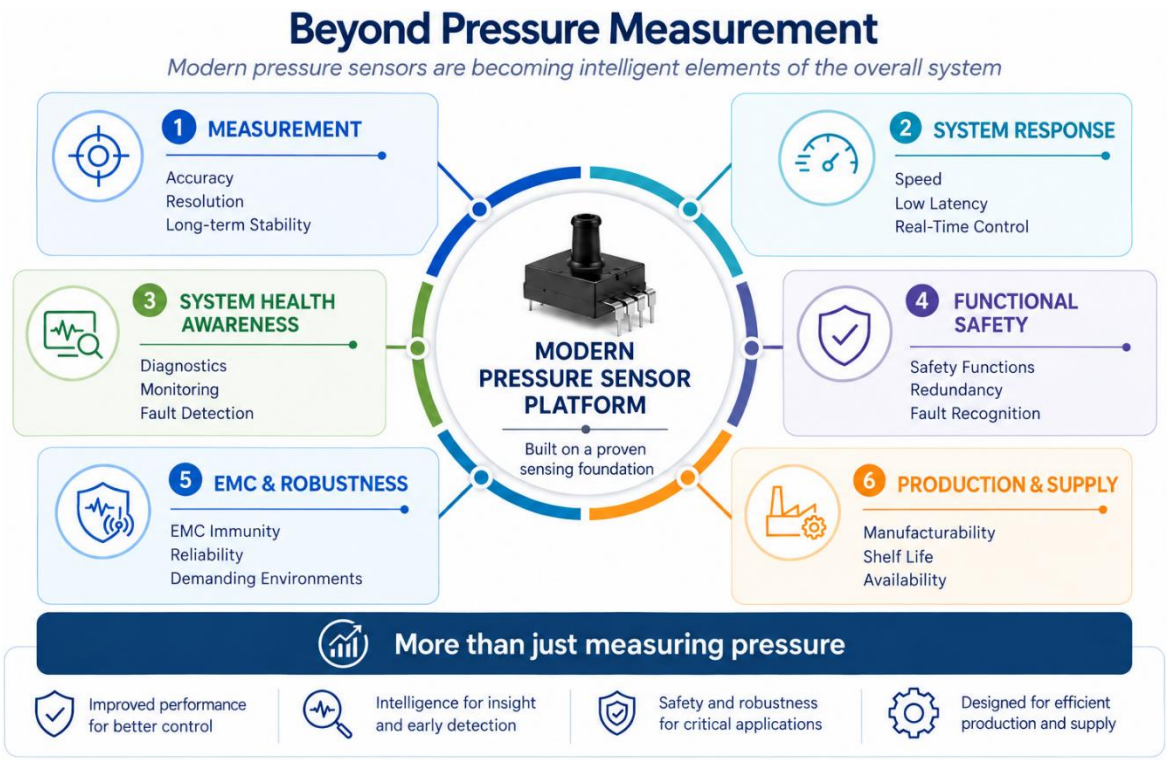
The precise and reliable measurement of pressure remains the primary function of a pressure sensor. However, building on a high-performance sensing element, modern sensor platforms can now contribute significantly more to the performance and reliability of the overall system.

Higher resolution and **faster signal processing** make it possible to accurately detect even small or dynamic changes in pressure and make this data available for fast control loops. At the same time, more powerful sensor electronics open up new possibilities for diagnostics and system monitoring. The sensor can not only provide measured values, but also supply additional information about its own status or potential fault conditions.

Functional safety and high **electromagnetic compatibility (EMC)** are also becoming increasingly important in many applications. In increasingly complex and networked devices, the sensor must operate reliably whilst also helping to detect critical conditions at an early stage.

However, the requirements do not end with the operation of the sensor. A modern sensor design should also facilitate efficient integration into production and take into account requirements relating to shelf life, processing and long-term supply.

This broadens the role of the pressure sensor: it transforms from a precise transducer into an intelligent system component that combines performance, diagnostics, safety, robustness and efficient production.



7. Continuous development of the platform

Building on what has been tried and tested. Continuously developing further

New requirements do not necessarily have to lead to a completely new platform. Often, the targeted further development of a tried-and-tested technological foundation offers considerable advantages.

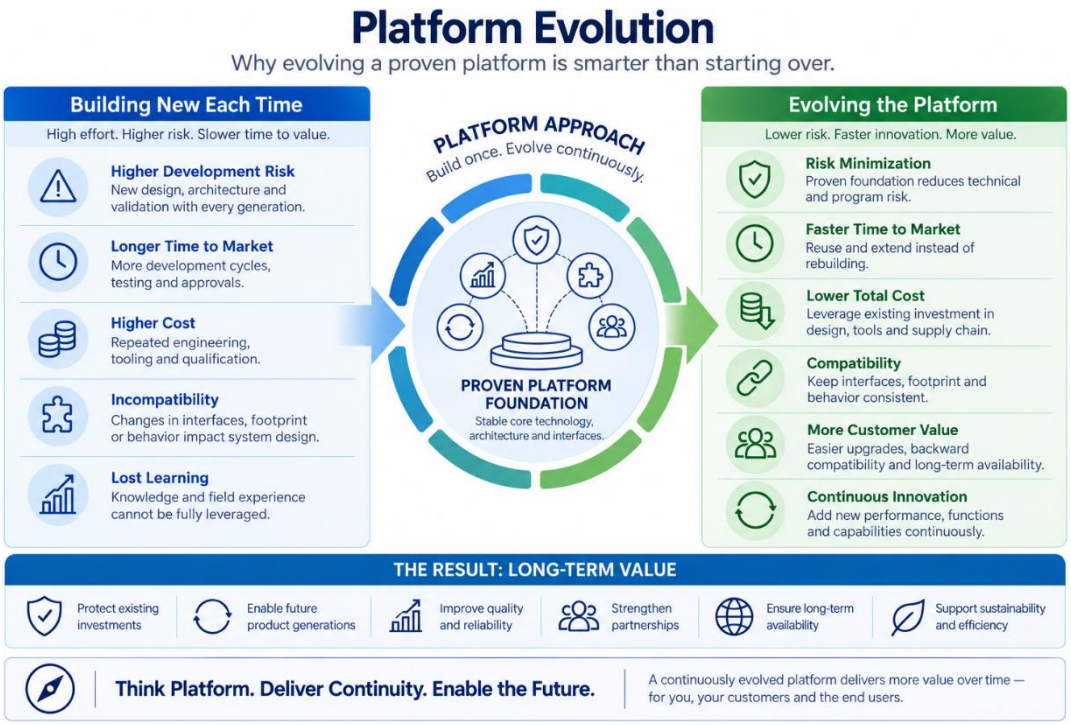
With each new generation of products, requirements in terms of measurement performance, functions, safety, interfaces and reliability change. If each change is addressed with a completely new architecture, this results in additional development and qualification work. At the same time, technical risks increase and existing experience can only be utilised to a limited extent.

A **continuous platform strategy** takes a different approach: **Tried-and-tested core technologies, architectures and interfaces are retained as far as possible, whilst new functions and enhanced performance are added in a targeted manner.**

This enables existing designs and development expertise to be utilised across several product generations. Compatible interfaces, form factors and mechanical dimensions, as well as defined migration paths, facilitate the further development of existing products and reduce the effort involved in introducing new generations.

For manufacturers, this means: **lower development risks, better protection of existing investments and easier modernisation of existing products.** At the same time, new technologies and features can be integrated gradually, without having to start from scratch with every new generation.

The long-term value of a platform therefore does not lie solely in its current capabilities. What is crucial is its ability to **preserve what has been tried and tested whilst at the same time enabling continuous further development.**



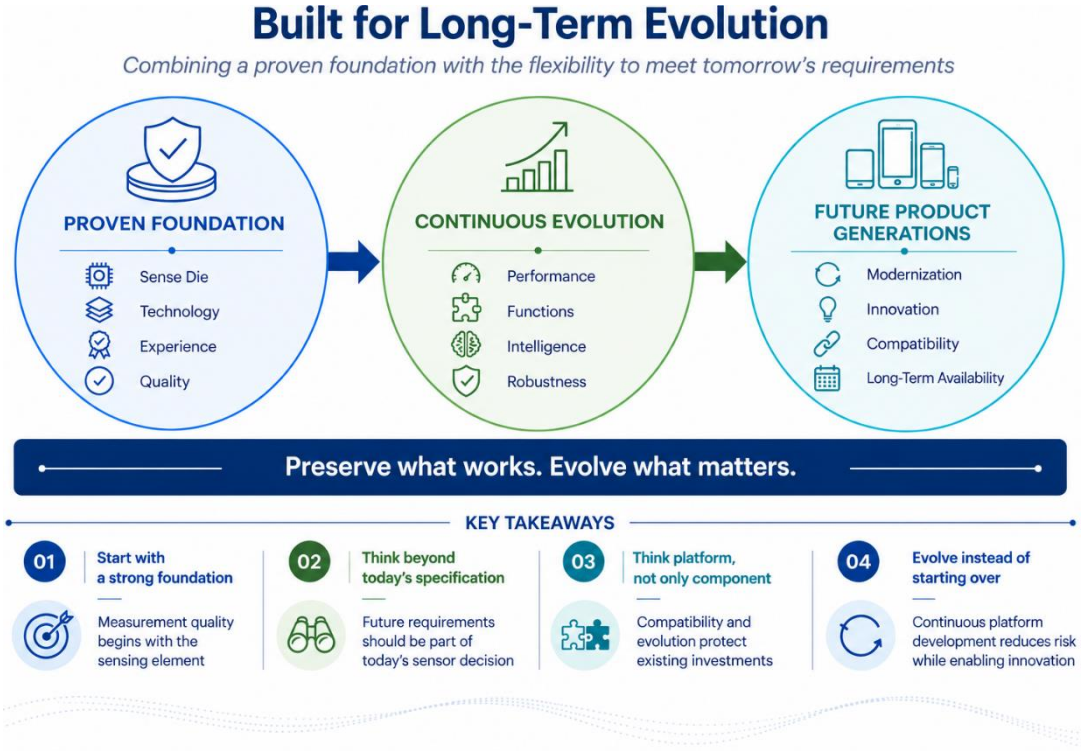
8. Designed for continuous development

Combining a tried-and-tested foundation with the flexibility to meet future requirements

Conclusion:

A forward-looking sensor platform therefore combines stability with the capacity for change: it safeguards tried-and-tested solutions, reduces development risks and, at the same time, lays the technological foundations for continuous further development.

The sensor choices we make today lay the foundations for the product generations of tomorrow.



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