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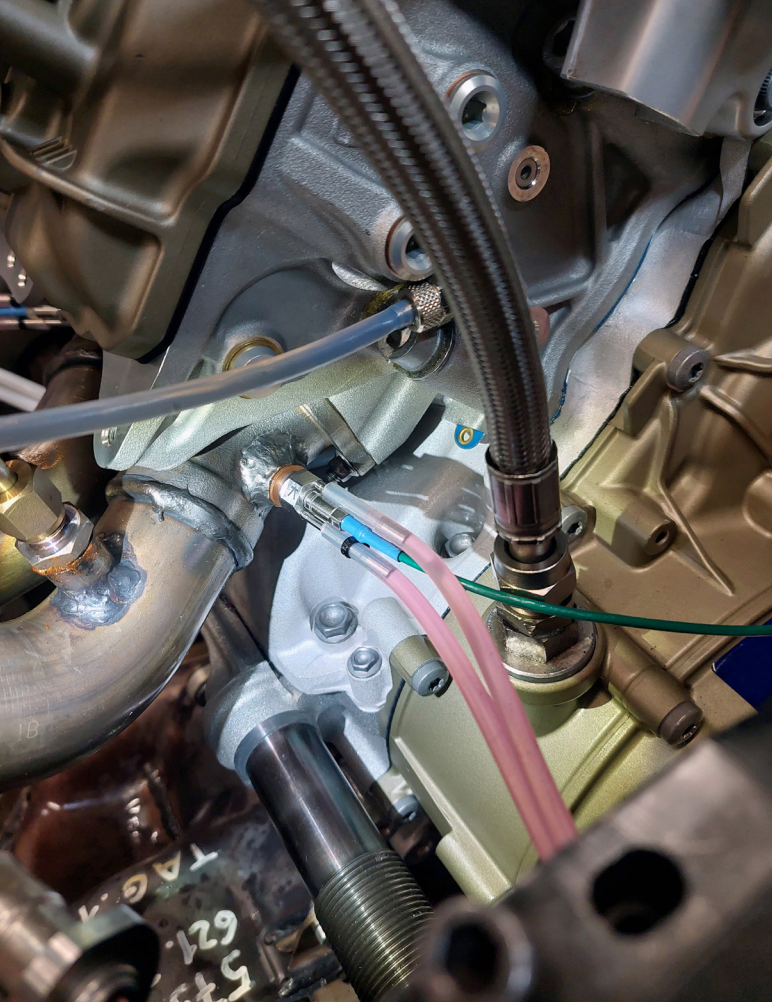


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# **SUSTAINABLE PERFORMANCE EVEN IN TIMES OF CHANGE**

Ducati and Kistler – close collaboration in engine development – also for sustainable fuels





Setup of the 4017A...W water-cooled piezoresistive exhaust sensor set for pressure measurement under different engine speed and load conditions (close-up of cylinder 4).

**From in-cylinder pressure measurement to combustion analysis with sustainable fuels: measurement technology from Kistler – both piezoelectric cylinder pressure sensors and piezoresistive pressure transducers – supports the development of high-performance engines at Ducati and enables efficiency, reliability, and innovation across the board.**

For more than two decades, Ducati has trusted measurement technology from Kistler for in-cylinder pressure measurement – a critical metric for understanding and optimizing combustion. Ducati's choice comes down to one thing: Kistler's ability to deliver ultra-precise data even in the harshest operating conditions, backed by a collaborative mindset and unwavering partner support. Over the years, the partnership has continued to evolve, driven by a shared ambition: to generate ever more accurate insights that refine the calibration and validation of high-performance engines.

#### **A long-standing partnership built on precision**

Over the years, Ducati has adopted a range of Kistler solutions for in-cylinder pressure measurement, moving from customized M5 cylinder pressure sensors to the latest-generation models such as the 6054C. This technological evolution has been supported by close technical collaboration and the joint development of tailored solutions designed to meet increasingly sophisticated testing demands in engine development.

Today, alongside piezoelectric cylinder pressure sensors,

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“A failure today isn't just a technical problem – it has a direct impact on brand reputation. That's why we rely on cylinder pressure sensors that deliver precision at high pressures, which are critical for performance, as well as at low pressures, which are essential for fully characterizing the combustion process.”

Daniele Beleggia, Test-bench engineer at Ducati

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Ducati also deploys miniature piezoresistive absolute pressure sensors such as the 4017A to capture pressure in the intake and exhaust manifolds, enabling a complete view of the thermodynamic cycle.

#### **In-cylinder pressure measurement under extreme conditions**

Performance and reliability have always defined Ducati. Its naturally aspirated, ultra-high-revving engines challenge any measurement technology: extreme loads and vibration call for sensors that are exceptionally robust and precise, capable of delivering stable data even under irregular combustion or knock events. “In our test cells, the engines run at exceptionally high speeds,” says Marco Magnani, test-bench engineer at Ducati Corse. “The vibration and pressure levels are extremely intense – a truly demanding environment for any sensing technology.”

The 6054C piezoelectric cylinder pressure sensor from Kistler delivers thermal stability up to 350°C and a frequency response exceeding 100 kHz, capturing even the smallest pressure fluctuations inside the cylinder – including during the fastest transients. Its high accuracy and signal repeatability allow engineers to spot combustion irregularities with precision, helping prevent knock events and premature component wear. This makes in-cylinder pressure measurement a critical tool not only for engine calibration, but also for tracking reliability over the engine's lifetime. The data gathered by Kistler sensors enables Ducati to evaluate combustion quality and cycle efficiency, ensuring stable, repeatable performance.



High-performance engine development: The iconic Ducati logo on the façade of the company's headquarters in Borgo Panigale, Bologna.



The Kistler 6054C series enables highly accurate and durable cylinder pressure measurements from development through validation. The reinforced 6054CU20 version measures up to 400 bar and offers exceptional robustness.

In recent years, the company has expanded their use to endurance testing to understand engine behavior across its entire lifecycle. “Our top priority is ensuring maximum reliability,” says Daniele Beleggia, test-bench engineer at Ducati. “A failure today isn’t just a technical problem – it has a direct impact on brand reputation. That’s why we rely on cylinder pressure sensors that deliver precision at high pressures, which are critical for performance, as well as at low pressures, which are essential for fully characterizing the combustion process.”

### **Sustainable fuel engine testing**

Alongside the pursuit of ever-higher performance, Ducati is now navigating the transition toward more sustainable fuels – a challenge shared across the entire automotive sector. The goal is to reduce environmental impact without compromising the technical and sporting DNA that defines every Ducati engine. Testing fuels with sustainable components requires extremely precise measurements to understand combustion dynamics and ensure consistent performance. “Testing a new fuel means analyzing the combustion process, and that requires in-cylinder pressure data. Measurement technology from Kistler naturally supports us in these evaluations,” Magnani explains.

The signal quality and thermal stability of the cylinder pressure sensors enable real-time evaluation of key combustion parameters, such as ignition timing and heat-release rate, providing the critical data needed to compare the efficiency of different fuels – from conventional to bio-based.

### **Simulation validation in engine development: the role of piezoresistive sensors**

In addition to piezoelectric sensors, Ducati also relies on 4017A miniature piezoresistive absolute pressure sensors from Kistler. Mounted in the intake and exhaust manifolds, they allow engineers to compare simulation models with real-world data, offering a clearer and more dynamic view of how the engine behaves. This integrated approach has improved consistency between simulation and reality, giving development teams concrete parameters to work on.

A clear example concerns exhaust after-combustion events, a phenomenon that once caused valve failures.



Engine development: by measuring pressure in intake and exhaust manifolds, piezoresistive miniature absolute pressure sensors such as 4017A...W (left) and 4017A (right) from Kistler provide additional information for the validation of simulation models.

“We investigated the issue using sensors installed on the exhaust,” Beleggia recalls. “The measurements immediately revealed the problem: the after-combustion events were causing the valves to open uncontrollably, leading them to collide and break.”

Thanks to direct measurement, the Ducati team identified the root cause and resolved the issue once and for all. “In that case, the sensor data was decisive,” adds Magnani. The integration of Kistler’s piezoresistive and piezoelectric sensors now enables Ducati to monitor the entire combustion cycle – from intake to exhaust – with continuous, high-precision data, turning those insights into targeted, meaningful development actions.

### **Designing high-performance engines for sustainable fuels**

In the coming years, Ducati will introduce a new generation of engines designed for environmentally sustainable fuels. This transition brings together two sides of the same technical challenge: reducing environmental impact while preserving the performance-driven DNA that defines the brand. “From 2027 onward, we’ll have an entirely new engine, with reduced displacement and renewed fuels,” Magnani reveals. “In this phase, Kistler sensors will once again play a crucial role.” The collaboration will advance with new sensor generations that integrate seamlessly with existing acquisition systems and deliver an even deeper level of analysis. The goal remains the same: turning measurement precision into the knowledge that drives innovation.

### **Looking ahead: continuing collaborative innovation**

The partnership between Ducati and Kistler is rooted in trust and ongoing collaboration between their technical teams. “Among our suppliers, Kistler is one of the few we work with in such an open and direct way,” Beleggia says. “We value how available they are and how fast they react, even when things get complex. Price matters, but the real value of a partnership lies in the quality of the support.” As the industry shifts toward new sustainability standards, Ducati and Kistler share the same vision: to keep innovating, with excellence driving every decision.

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