KISTLER

measure. analyze. innovate.

Pioneers of sustainable motorsports

For vehicle development of its new hydrogen-powered race car, Forze Hydrogen Racing relies on Kistler

Forze
HYDROGEN RACING
PARTNERED BY SHELL

www.kistler.com

A 4624AK amplifier from Kistler is integrated in the Forze IX motorsports race car from Forze Hydrogen Racing; it transmits signals from different piezoresistive pressure sensors to the hydrogen car's control system.

The Forze IX is the latest hydrogen-powered race car designed and developed by Dutch students based in Delft. In the process, multiple Kistler solutions are used to measure pressure, temperature, torque, and vehicle dynamics. Dual fuel cells, zero emissions, race-winning performance and outstanding safety: assets that make the Forze IX a truly impressive achievement.

Sustainable motorsports: isn't that a contradiction in terms? Not for Forze Hydrogen Racing! Founded back in 2007 when the hydrogen economy of the future was still a distant prospect, this student team in the environment of the Delft University of Technology started out by developing a small go-kart. Today's Forze team is now working on the ninth generation of hydrogen-powered vehicles: the Forze IX is a full-size Le Mans Prototype race car with impressive performance statistics – acceleration from 0 to 100 km/h in under 3 seconds, a top speed of 300 km/h, and fuel cell power of 240 kW (600 kW with boost). With their new vehicle, the Forze team aims to compete against petrol-powered cars in the GT class of the Supercar Challenge – showing what is possible with race cars powered by hydrogen, the environment-friendly alternative.

Forze is short for Formula Zero, a series of zero-emission motorsports championships held between 2008 and 2011, which the Dutch team won three times in a row in their early years. "We then decided to make the step towards full-size hydrogen race cars so we could continue developing hydrogen technology. The first car in this series, the Forze VI, still holds the lap record for hydrogen-powered cars at the Nürburgring," says Thomas Noordzij, who shares responsibility for PR and Marketing at Forze with a colleague. "But that was long before I joined the team in August 2022. We start out with a new selection of students every year in August." About 30 full-timers and 30 part-timers now work for Forze, which eventually became an independent foundation, separate from the university. "They aren't paid while they are working for Forze, but of course they gain invaluable experience and practical insights during their time here," Noordzij adds. "To ensure continuity, Forze alumni stay connected in our network and are available to provide knowledge and support for the current team if necessary."

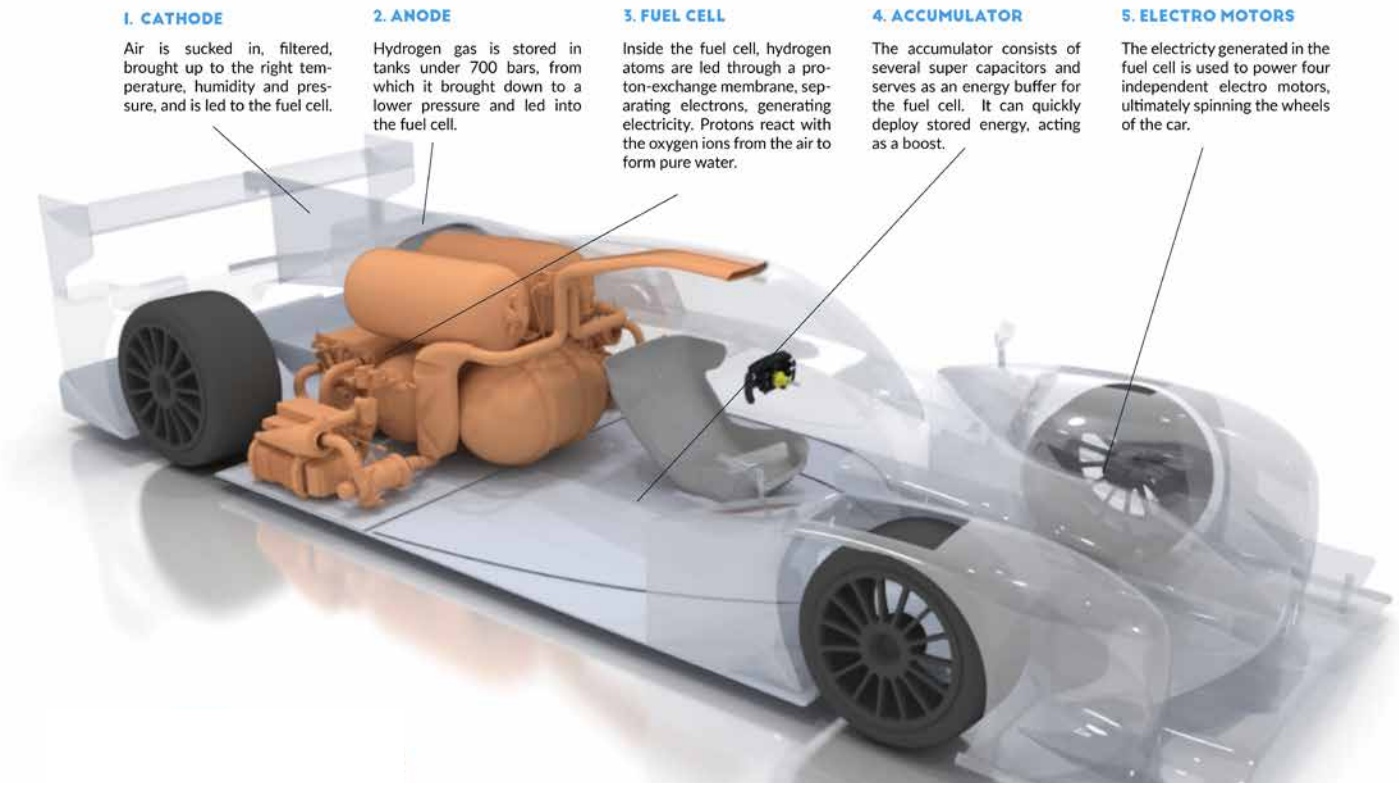
Piezoresistive pressure sensors monitor fuel cell stack

Forze benefits from a diverse network of partners who offer technology, management support and funding: among their number is Kistler. The measurement technology experts provide Forze with various sensors and systems for vehicle development: instrumentation to regulate the fuel cell stack is one key aspect, along with other more performance-related solutions. Development is still in progress on the new Forze IX, which will be the first in the series to have two fuel cells, thus doubling the power transmitted to four independent electric motors – one for each wheel. There are also four built-in hydrogen tanks with a total capacity of 8.4 kilograms of the volatile gas. Noordzij again: "We're delighted to have Kistler as our domain partner. First contact was made in 2017, and their products have always been of the highest quality – reliable, and easy to use. What's more, Kistler has such a wide-ranging portfolio that we can apply their products to many different systems in our car. Kistler technology will definitely help us push for greater reliability and performance once the car hits the race track."

Compact and multifunctional: key advantages

In vehicle development, Forze uses a Kistler 4080BT pressure and temperature transducer – which was specially developed for racing applications – to measure the cooling fluid immediately upstream of the pump in the fuel cell cooling cycle. Since the temperature rise inside the pump is negligible, this transducer is also used to measure the temperature before the inlet of the radiator, which ultimately cools the cooling fluid. "This allows us to evaluate the cooling performance," says India van Doornen, Chief Engineer at Forze. "We also use 4080BT transducers in the front and rear drivetrain cooling cycle. Especially here, packaging is a major challenge – so it's

Thomas Noordzij, PR and Marketing Manager at Forze Hydrogen Racing, is a member of the 16th student team for successful hydrogen motorsports since 2007.



Different Kistler measurement technologies are applied for vehicle development of the new Forze IX from Forze Hydrogen Racing – including sensors for pressure, temperature, torque, and vehicle dynamics.

very beneficial that the Kistler sensors are extremely small as compared to the alternatives. And the sensors' ability to measure both pressure and temperature makes them efficient to operate."

> "Kistler solutions help us to optimize our car's reliability and performance. It's a win-win situation for both partners: helping to develop innovative measurement technology for hydrogen in – and beyond – sustainable racing applications."
>
> Thomas Noordzij, PR and Marketing at Forze

A second piezoresistive pressure sensor, the 4007D from Kistler, is used on the cathode side of the fuel cell system to measure air pressure inside the fuel cell. "This is one of the most important sensors on the cathode side, because the compressor is such a crucial element," van Doornen points out. "It's generally very easy to set up and customize sensors and amplifiers from Kistler for our purposes. So we didn't need any technical support until now, but our contacts with Kistler have always met with fast and supportive responses."

Going head-to-head with petrol-powered cars – despite zero emissions

Track tests for the Forze IX are planned for spring 2023, and the first race will likely take place this summer. Noordzij again: "We'll then be up against petrol-powered Porsches and Lamborghinis in the Supercar Challenge – and we're of course keen to enter our first race! As well as competing in these races, we participate in national and international events focusing on hydrogen and motorsports – and we organize 'Track Days' about once a year. Spreading knowledge about the technology, and promoting hydrogen and fuel cells, are key elements of our work." By then, Forze will have applied even more Kistler technology for vehicle development: one example is the Correvit SF-Motion racing sensor that can measure not only speed, lateral and longitudinal accelerations but also pitch and roll angles – highly dynamically and even under challenging environmental conditions. "This holistic sensor will be used during testing this spring. Thanks to its broad functionality and high accuracy, we can use it to evaluate large numbers of other sensors that are already integrated in the car," van Doornen explains.

Last but not least, Kistler will provide Forze with a newly developed solution: the KiTorq DS sensor, designed specifically for high-performance automotive applications including motorsports. It will be used to monitor fatigue of the driveshaft, which is subjected to heavy loads when the accumulator boost is engaged. This new feature of the Forze IX is charged by recovering energy during braking and with excess power from the fuel cell; it achieves rapid acceleration, but also exerts a heavy load on the driveshaft as compared to regular fuel cell power. Final words from Thomas Noordzij: "All these Kistler solutions help us to optimize our car's reliability and performance. It's a two-way process, because we also test and validate the prototypes, and send our data from the race track back to Kistler. So it's a win-win situation for both partners: helping to develop innovative measurement technology for hydrogen in – and beyond – sustainable racing applications."

Find out more about our applications:
www.kistler.com

Kistler Group
Eulachstrasse 22
8408 Winterthur
Switzerland
Tel. +41 52 224 11 11

Find your local contact at
www.kistler.com

KISTLER
measure. analyze. innovate.