VEHICLE DYNAMICS INTERNATIONAL
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A new era of body control

Mercedes-Benz has developed a comprehensive body control system, which debuts in the GLE. We bring you the inside story

A master of steering feel

Dave Coleman, vehicle dynamics manager at Mazda R&D North America, reveals his thoughts on optimizing steering feel

Interview: Jost Capito

VDI joined VW R boss Jost Capito on the T-Roc R chassis test program to get his thoughts on dynamic setups

Vehicle Dynamics International Awards

The innovative cars, dynamicists and technologies that most impressed our judges this year

MAY/JUNE 2019

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The GLE model marks the introduction of Mercedes-Benz's E-Active Body Control technology, which enhances both on-road manners and off-road ability

What's new?

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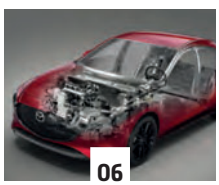

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Product & service profiles

"A lot of rivals have a poor base chassis and they try and mask it with electronics. With me the base chassis has to be good with everything switched off"

Jost Capito, Volkswagen R

A note from the editor

Wise words

There is such a lot of great insight in this issue of *Vehicle Dynamics International* that I'm going to let its content speak for itself. For example, we have Dave Coleman, Mazda R&D North America's vehicle dynamics manager, advising on the importance of steering feel and why his team has developed a bespoke EPS system: "We almost wrap our whole company around the idea that 99% of drivers don't know that they care about steering feel, but 100% of them actually do. People who drive cars with good and bad steering feel will think that the one with good steering feel drives better, but they won't be able to tell you why." On page 36 Coleman shares his thoughts on why Mazda customers enjoy great steering feel.

We also gain dynamics acumen from a huge name in motorsport who is becoming a big name in the automotive industry: Jost Capito, who has recently been appointed boss of Volkswagen's R division. Capito's ethos is to focus on getting the basics right before looking to technology. "A lot of rivals have a poor base chassis and they try to mask it with electronics. With me the base chassis has to be good with the electronics off. Electronics are for safety, not for making a better chassis."

Find out on page 18 what he looks for in a car chassis design and how it should feel to drive. As someone who sees rock-hard suspensions on road cars as a little ridiculous, his phrase "stiff isn't quick" is music to my ears.

We also hear from Simon Kern, who was a key figure in developing Mercedes-Benz's E-Active Body Control system. He extols the virtues of increased processing speeds and swapping electromechanical controls for electrohydraulic systems to improve roll and pitch control, and achieve excellent ride comfort. Exciting work, which debuts on the GLE (page 4).

Further innovation is explored and recognized in the 2019 Vehicle Dynamics International Awards, the results of which are announced on page 26. Without spoiling the surprises, here's what our global judging panel and the CEO of an OEM had to say about this year's winners: "Passengers have the sensation of floating over bumps and hollows"; "A complete modular solution designed to satisfy the requirements of vehicle manufacturers, tire developers, dynamicists and race engineers alike"; "Wow, there were some very impressive cars on the shortlist this year"; "It's incredible how such powerful supercars can be so easy to drive extremely fast, and be so easy to control if you want to play with some slide! This is thanks to 4WD and perfect suspension settings…"

The 2019 awards have highlighted some truly impressive innovative thinking and technology, and I can't wait to see what the coming year brings.

Adam Gavine, editor

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Body control technology

A comprehensive body control system has been developed by Mercedes-Benz, for debut in the GLE model. Kyle Fortune finds out more and tries out the system

"That's me in the car," says Simon Kern, the man in charge of developing E-Active Body Control at Mercedes-Benz. We're watching a video of a GLE extract itself from axle-deep sand, the suspension bouncing the car, each wheel operating independently to allow the GLE to drive itself free.

Active suspension is nothing new at Mercedes-Benz, with the company having explored such systems as long as 40 years ago. We're familiar with the Road Surface Scan and Curve features of the S-Class, but with E-Active Body Control there are some core differences.

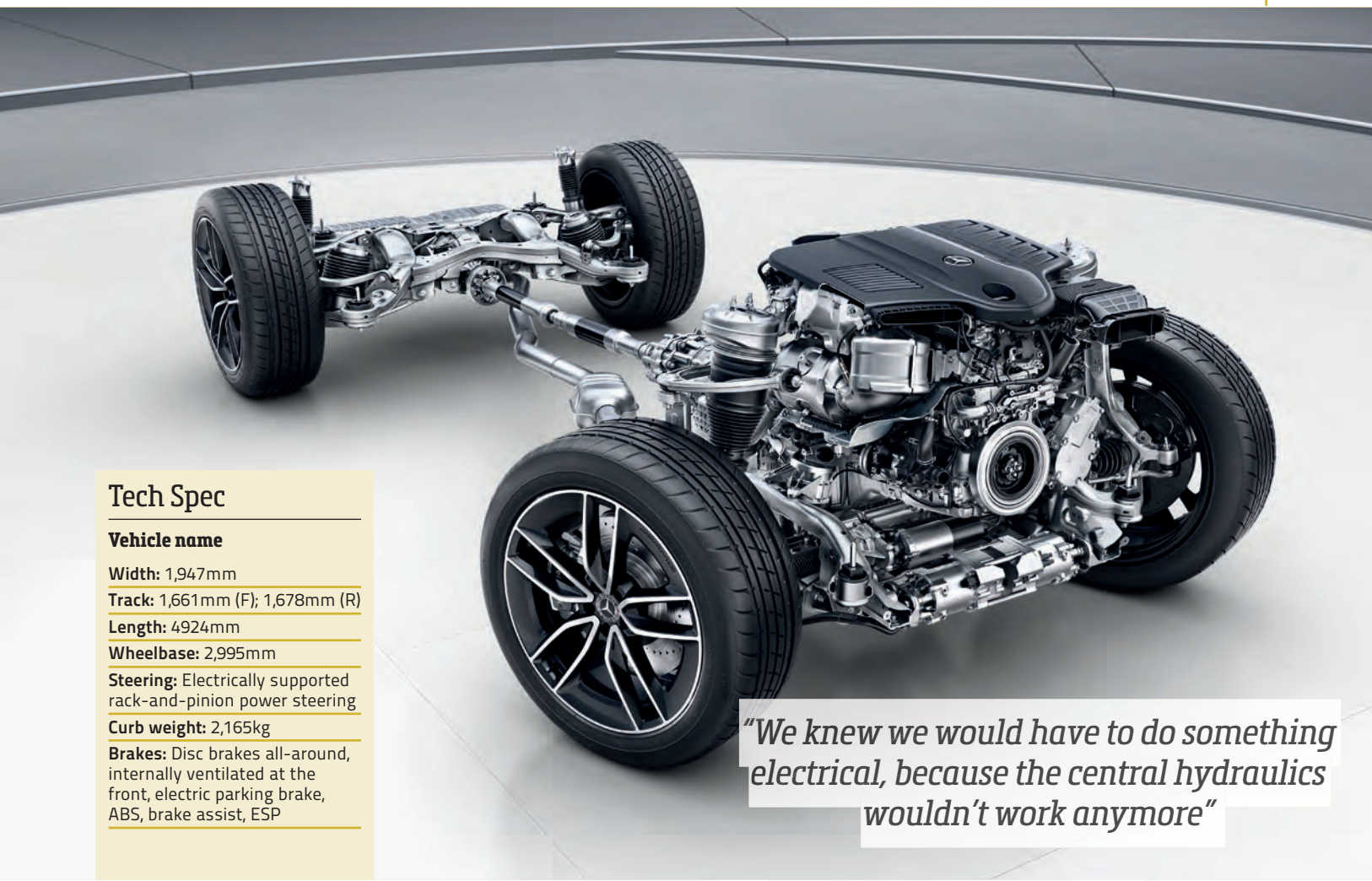
"With the S-class we compensate every roll hit with the multi-seeing camera we introduced scanning of the road in front of the car," explains Kern. "That helps the controller, because it can act in advance [of a road issue]. It's proactive. Developing all these features was our first intention. Then we had these additional ideas for off-road use," says the chassis engineer.

ABOVE: E-Active Body Control helps make the GLE driving experience as comfortable on rough road surfaces as on tarmac

Employing a 48V onboard electrical system, the E-Active Body Control (developed by RAPA – see p48) not only allows active roll stabilization, but also acts on lifting and pitching on the body. In the Curve driving mode, the GLE is lifted by as much as 3° to counter the forces acting on the passengers inside. The unique features that help off-road driving include the 'recovery mode'.

Kern's just been demonstrating with the sand scenario, as well as the ability to individually move each wheel via the touchscreen inside, to enhance off-road ability in the toughest situations. Kern admits that few owners are likely to ever get themselves into such a scenario, but suggests that the on-road benefits are compelling, too.

The objectives for E-Active Body Control were full roll and pitch control for improved driving dynamics, all combined with good ride comfort. Kern admits that key to the system's success is the increased processing speed and



Tech Spec

Vehicle name

Width: 1,947mm

Track: 1,661mm (F); 1,678mm (R)

Length: 4924mm

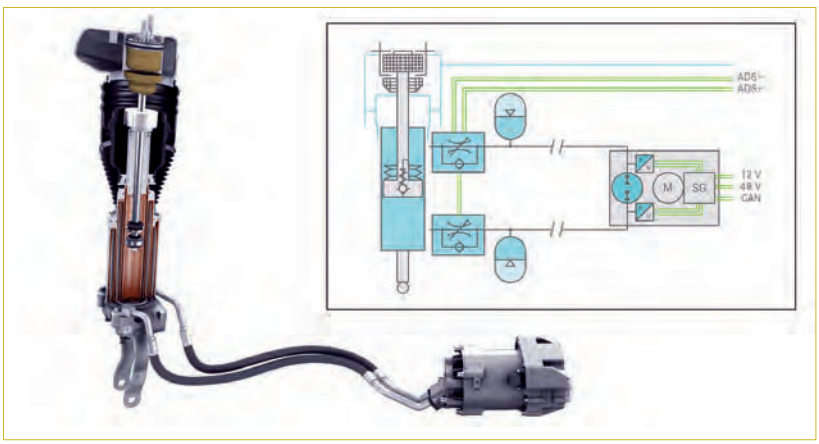
Wheelbase: 2,995mm

Steering: Electrically supported rack-and-pinion power steering

Curb weight: 2,165kg

Brakes: Disc brakes all-around, internally ventilated at the front, electric parking brake, ABS, brake assist, ESP

"We knew we would have to do something electrical, because the central hydraulics wouldn't work anymore"



ABOVE: With the GLE, the Airmatic air suspension is available for the first time with the ADS Plus continuously variable damping system

ABOVE LEFT: RAPA's E-Active Body Control system. See p48 for more details

the adoption of electrohydraulic rather than electromechanical controls.

"We have a lot of actuation through the pump, and leveling with the air springs, with individually accessible valves for compression and rebound," says Kern. Each damper has a continuously adjustable damping valve and hydraulic accumulator.

The dampers are all connected to their own motor pump unit for individual control. Able to create active force, and easily and quickly modulated, the electric motor powering them can reach very high speeds immediately to benefit vehicle control.

Kern says the motor pump unit can run at speeds of up to 70,000rpm. Power usage is typically 150W, rising under peak performance. The electrohydraulic system is also beneficial because it is self-lubricating, very low friction and self cooling, and offers relatively easy packaging solutions. The unit is fitted to the mounts for the anti-roll bar in the passively suspended GLE. The E-Active Body Control system adds around 50kg (110 lb) to the vehicle's overall weight.

Kern says, "With the S-Class we had a central hydraulic system that always needs the engine to be running. We knew with the new hybrid models we would have to do something electrical, because the central hydraulics wouldn't work anymore."

E-Active Body Control's electric power also has the benefit of future-proofing the active suspension system for the increasingly electrified powertrains that Mercedes-Benz is adopting today. It allows the system to work with combustion engines, and eventually full BEV applications. In the GLE, E-Active Body Control uses the starter-alternator, with the 48V system controlled by an energy management system.

In practice it all works fairly convincingly, with the GLE's ride impressively flat, although when the Curve function leans to compensate for bends it can feel a touch unnerving and unnatural. It's not a cheap option either – for now at least.

Intelligent SUV chassis

RAPA has developed a unique motor pump unit for the E-Active Body Control chassis, as fitted to the trend-setting Mercedes-Benz GLE

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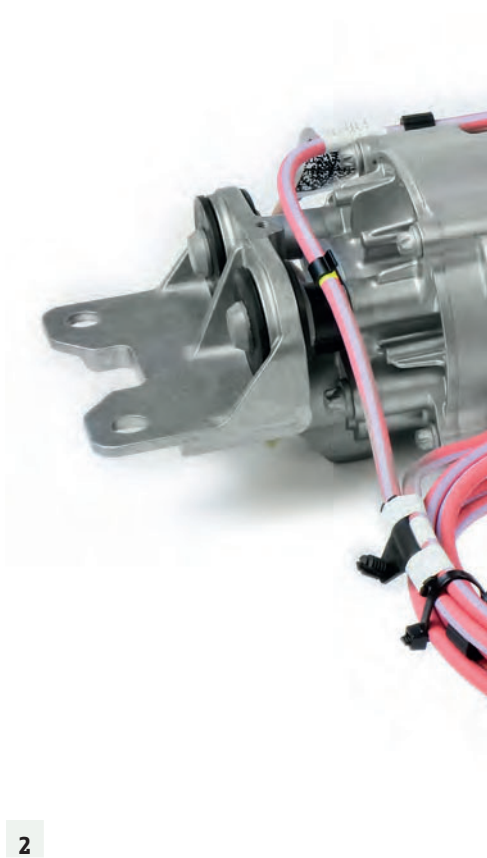

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FIGURE 1: An individual eABC motor pump unit

FIGURE 2: An axle set for the eABC

After six years of development, Rausch & Pausch GmbH (RAPA), based in Selb, Germany, has created a motor pump unit with integrated control electronics for the E-Active Body Control (eABC) in the new Mercedes-Benz GLE SUV.

eABC – a milestone technology in RAPA's company history – is a further development of its established ABC system. The traveled road surface is recorded with the help of a stereoscopic camera, and a corresponding control algorithm is created that enables the vehicle's passenger compartment to be kept level and horizontal in any given driving situation.

Four corner modules, which consist of a motor pump unit and an active strut, with the shock absorber used as an actuator. Roll and pitching movements are compensated for by the system. The ride height can be changed, for example lowered for driving on the highway and raised for rough terrain.

The motor pump unit consists of three main components: an internal gear hydraulic pump, a permanently excited synchronous machine as an electric motor, and a 48V control device, which uses software from cooperation partner, Silver Atena.

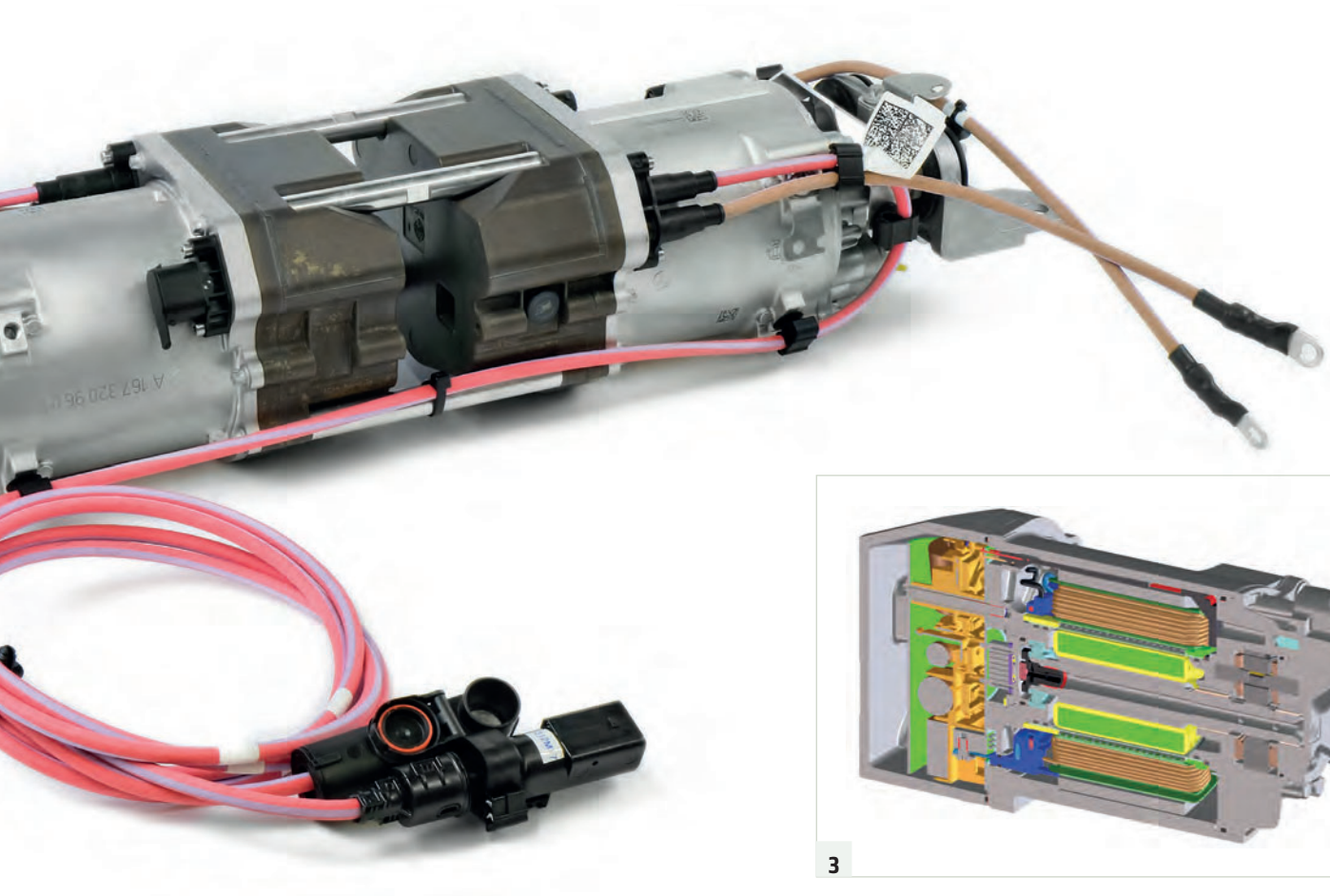
For the displacement principle to work, a four-quadrant-capable internal gear machine with leakage compensation has been specified, with a volumetric efficiency of almost 100%. The high efficiency is necessary to prevent active cooling.

As well as the unit having four-quadrant capability and very high volumetric efficiency, its specified displacement enables a compact design and the best possibility for optimal integration between the displacer and the electric motor.

With regard to the electrical components, RAPA decided to use a permanent-magnet synchronous machine. The machine includes a wet runner with crevice tube, which represented a big challenge for the development team, such as having to achieve both high efficiency and pressure resistance under all operating conditions, which are at least 150 bar.

After numerous structural-mechanical simulations, RAPA developed a now-patented design for a crevice tube that supports itself on the stator teeth when it is under pressure and automatically braces.

The integrated electronic unit consists of a performance circuit board and a signal circuit board. The electronics provide numerous parameter variables for the motor pump unit on the CAN connection. As well as typical parameters such as rotation speed, temperature,



input voltage and current consumption, two pressure sensors that are integrated into the hydraulic machine also provide the current operating pressure of the two hydraulic connections for the motor pump unit on the CANbus. The power electronics are of special significance to the overall performance of the eABC, in particular due to the high system-based safety requirements (ASIL-Level C).

The integration requirements of the unit necessitated a highly integrated design for the whole motor pump unit. For this reason, the hydraulic displacement machine and the electrical machine are integrated, connected by a single shaft. Depending on the installation space requirements in the vehicle, the various bracket designs mean that the motor pump unit can be installed either as an individual motor pump unit or as complete motor pump unit axle set.

The driving comfort that has been achieved, and additional features such as override mode or curve function, mean that this is a tangible and highly beneficial improvement for customers.

For Daimler, the systematic development of the fully active chassis is one of the three most important innovations in the new-generation GLE.

FIGURE 3: A cross-section of the eABC motor pump unit

FIGURE 4: The new trend-setting Mercedes-Benz GLE

For RAPA, the development of the motor pump unit, in view of the system's complexity, was nothing less than the greatest challenge in the almost 100-year history of the company. In February 2019, Daimler presented RAPA with a special award as Most Innovative Supplier of the Year 2018.

Since the company was founded in 1920, Rausch & Pausch has become known for continuous development and innovative product solutions. In particular, its strategic vision in high-tech niches, as well as its reputation as a flexible development service provider, makes the medium-sized company a respected technology partner and a hidden champion in the automotive, medical and industrial sectors.

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