

Chassis & Safety Division

# Facts & Figures 2011



**Continental** 

## Active in Safety

Safety is not an objective concept – we may feel safe; but that doesn't mean we really are. When we're on the road, we are not alone; we have a responsibility not just towards ourselves and our passengers, but also to other road users.

Most car drivers will associate the term “driving safety” with airbags and effective seatbelt tensioners. Maybe also ABS or ESC. Indeed, these technologies have decisively contributed to reducing serious injuries and fatalities on our roads.

A really safe mobile future, however, calls for a true further thinking. Continental is convinced that driving without accidents through innovative technologies, for all vehicle classes and markets of this world, will be possible in the future. Driving safety for Continental means avoiding accidents in the first place with all possible active safety technologies and if this is not possible, to protect the driver with all possible means of passive safety technologies.

The technological diversity of active accident avoidance and their intelligent integration holds a large potential that should be exploited. Car drivers, however, do not seem to be aware of today's possibilities of active accident avoidance.

Safety is a communications task: Continental therefore strives to change the mindset on the topic of driving safety. Technologies such as ESC, Emergency Brake Assist, Lane Departure Warning or Blind-Spot Detection are therefore in the foreground when it comes to accident avoidance.

For one is sure: active safety technologies will help to achieve the goals of the EU: to half road fatalities by 2020. Will you actively shape the future with us at Continental?

The Chassis & Safety Division is one of six Divisions of the Continental Corporation with the focus on developing and producing intelligent and integrated systems for a safer automotive future. Chassis & Safety integrates the full range of active and passive safety systems, resulting in comprehensive vehicle safety and dynamics.

### Our structure reflects our core competences

Vehicle dynamics for cars that are safe and a pleasure to drive are an integral part of our mindset. Globalization, growth, and excellence are the major strategic thrusts in our Division, which is organized into five Business Units:

- Electronic Brake Systems
- Hydraulic Brake Systems
- Sensorics
- Passive Safety & Advanced Driver Assistance Systems
- Chassis Components

According to their individual specializations, these Business Units develop and produce electronic and hydraulic brake and chassis control systems, sensors, driver assistance systems, airbag electronics and sensors, windshield cleaning systems as well as electronic air suspension systems.



# Key Figures – an Overview

| Sales in € millions                    | 2010            | 2009            |
|--|-----------------|-----------------|
| <b>Chassis &amp; Safety Division</b>   | <b>5,775.4</b>  | <b>4,373.6</b>  |
| Powertrain Division                    | 4,730.8         | 3,399.2         |
| Interior Division                      | 5,518.1         | 4,362.7         |
| Passenger & Light Truck Tires Division | 5,820.8         | 4,696.4         |
| Commercial Vehicle Tires Division      | 1,427.8         | 1,065.6         |
| ContiTech Division                     | 3,095.3         | 2,406.1         |
| Others/Consolidation                   | -321.3          | -207.9          |
| <b>Continental Corporation</b>         | <b>26,046.9</b> | <b>20,095.7</b> |

| Production per year in millions | 2010    | 2009    |
|---------------------------------|---------|---------|
| Electronic brake systems        | 16.702  | 12.669  |
| Speed sensors                   | 132.800 | 101.920 |
| Brake calipers                  | 32.800  | 26.200  |
| Boosters                        | 15.100  | 13.074  |
| Air springs                     | 1.112   | 0.602   |
| Airbag controllers              | 12.440  | 11.513  |
| Airbag sensors                  | 40.174  | 33.590  |

| Employees at year end                  | 2010           | 2009           |
|--|----------------|----------------|
| <b>Chassis &amp; Safety Division</b>   | <b>30,495</b>  | <b>27,148</b>  |
| Powertrain Division                    | 26,614         | 24,172         |
| Interior Division                      | 29,614         | 26,710         |
| Passenger & Light Truck Tires Division | 28,276         | 26,510         |
| Commercial Vehicle Tires Division      | 7,156          | 7,594          |
| ContiTech Division                     | 25,833         | 22,079         |
| Others/Consolidation                   | 240            | 221            |
| <b>Continental Corporation</b>         | <b>148,228</b> | <b>134,434</b> |

## Sales by Regions: Continental Corporation

Dec. 31, 2010: **€ 26,046.9 million**

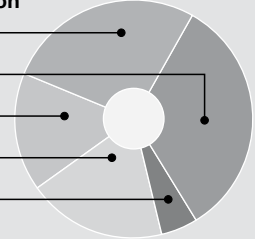
**27%** Germany

**33%** Europe without Germany

**16%** Asia

**19%** NAFTA region

**5%** Other countries



## Sales by Regions: Chassis & Safety

Dec. 31, 2010: **€ 5,775.4 million**

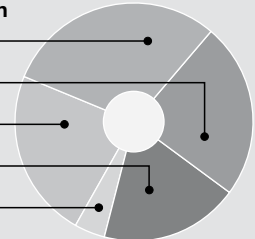
**30%** Germany

**24%** Europe without Germany

**23%** Asia

**19%** NAFTA region

**4%** Other countries



## Employees by Regions: Continental Corporation

Dec. 31, 2010: **148,228 Employees**

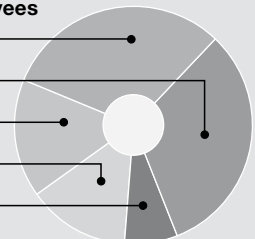
**31%** Germany

**32%** Europe without Germany

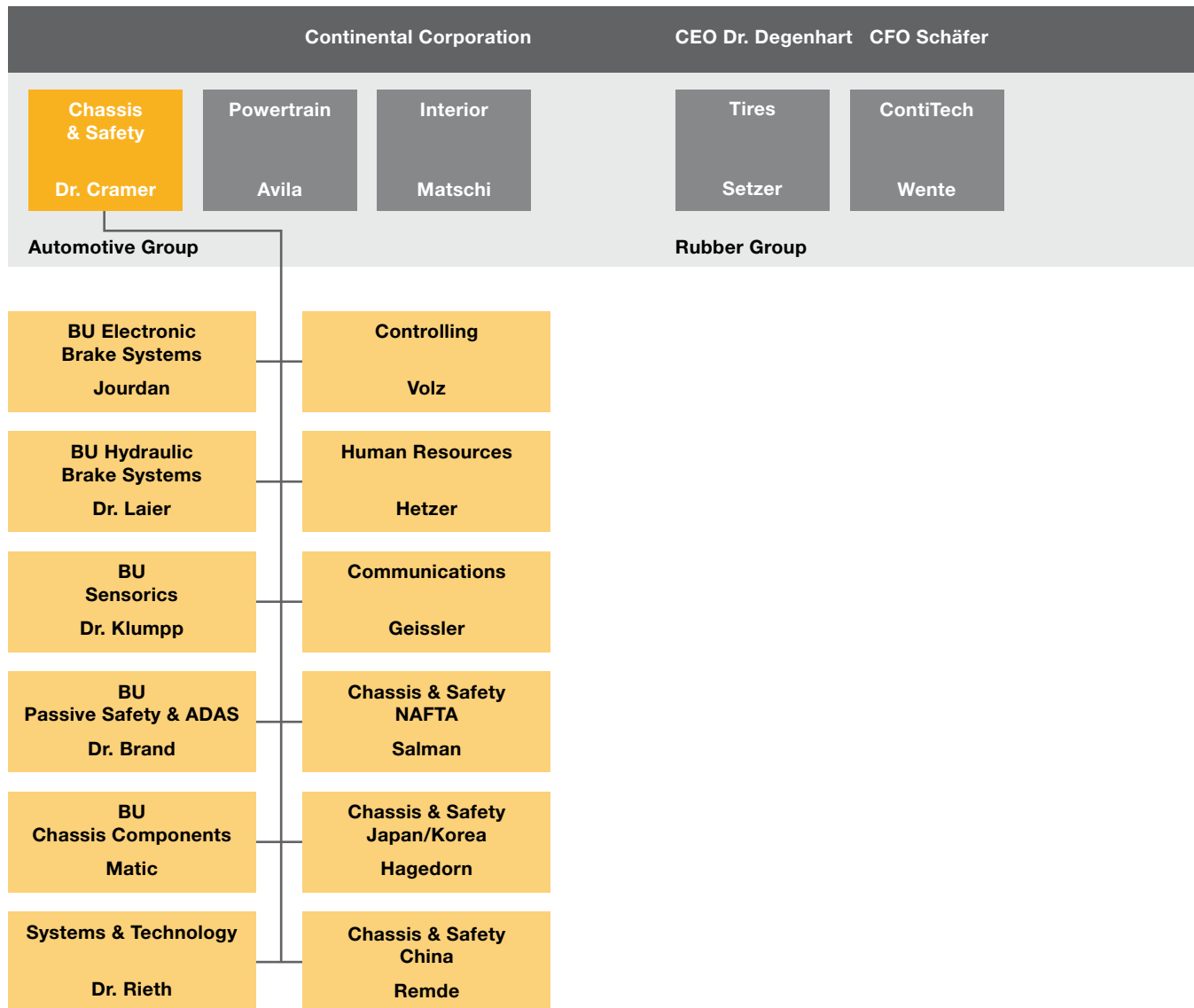
**16%** Asia

**14%** NAFTA region

**7%** Other countries



# Chassis & Safety Division within Continental Corporation



BU = Business Unit

## Driving You Safely: ContiGuard®

The Chassis & Safety division integrates first-class vehicle components and established systems know-how in driving safety and driving dynamics into the comprehensive safety concept ContiGuard®. The core competence “Vision Zero” for Continental means, intelligent and safer driving for all and in all markets of the world.

Continental distinguishes between five driving or safety phases, from normal driving to a final, unavoidable crash situation. Normal driving, too, means high demands on a driver, as well as the need for protection and proactive support. A decisive element is the accomplished interaction of all components in the Hazard phase and active accident avoidance.

If and when an accident could not be avoided in the end, it is by no means too late, but here, too, rapid action is required. Driving a car is an endurance test of our ability to identify and assess the factors around us and make quick decisions.

The aim of modern safety technologies is to support the driver in these many different tasks, and in processing information – with aid from active and passive safety systems that do not experience a moment of shock before responding. They provide the driver with feedback and advice, take action where needed, and help the driver to stay calm and in control of any driving situation. The driver's responsibility for the vehicle remains throughout.

### ContiGuard® opens up a new dimension of driving safety technology:

With ContiGuard®, Continental has opened up a new dimension of driving safety technology, as it integrates active and passive safety systems, enhanced by surrounding sensors and their coordinated interaction. With ContiGuard®, our customers can efficiently achieve a significant reduction of accidents and number of fatalities on the road to Vision Zero, or at least minimize the consequences and the risk of injury for all road users.

ContiGuard® is an anticipating, intelligent, damage-avoiding, comprehensive, scalable system and therefore part of our efforts to bring driving safety to all vehicle classes and markets.



For ContiGuard®, we have identified five different driving phases:

In order for driving to remain free from accidents:

- Normal driving
- Hazard

If it does come to an accident:

- Pre-crash
- In-crash
- Post-crash

During every driving phase, various technologies interact in a variety of ways to offer the driver, passengers, and all traffic participants an even safer driving experience.

### The Decade of Driving Safety

The United Nations General Assembly has proclaimed the period from 2011 to 2020 the Decade of Action for Road Safety, and based on a proposal put forward by the Directorate-General for Mobility and Transport (DG MOVE), the European Commission has published guidelines for road traffic safety for the same period. The goals of the new guidelines include reducing the number of traffic fatalities by a further 50 percent.

Every year, the equivalent of the entire population of a small city is killed in traffic accidents in the EU alone. As a result, there is a clear need for further improvements in traffic safety throughout Europe.

One thing is clear: Driver assistance systems and integrated safety systems like ContiGuard® are considered key technologies when it comes to enhancing driving safety. Without them, it would be difficult to achieve the goal of cutting traffic fatality figures in half by 2020.

## The different driving phases

### Normal driving: information

During normal driving the driver is supported by Advanced Driver Assistance Systems such as Adaptive Cruise Control or Speed Limit Monitoring.

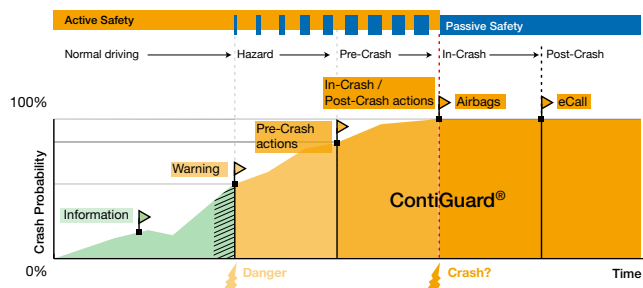
Drivers can maintain a safe distance to the car in front by means of an intelligent cruise control system and distance warning alerts. Lane departure warning systems improve lane discipline with the aid of camera data, steering intervention and haptic warnings. Lights are adjusted according to the weather conditions and time of day, speed restrictions are displayed and the radio or navigation device give traffic updates.

### Hazard: warning and support for avoiding accidents

Electronic brake systems and electric power steering (EPS) are key technologies for all intervening ContiGuard® functions. Forward looking brake assist functions from pre-braking to autonomous emergency braking become active in critical situations of distance.

When performing an avoiding maneuver the driver is also actively supported to keep the car safely on the road through adaptive chassis systems, such as active rear axle kinematics and active suspension systems and supporting intervention of the electric power steering. If necessary, stabilizing functions like ESC (electronic stability control) actively stabilizes the vehicle.

**If it does come to an accident, then the following three driving phases play an important role in reducing the risk of injuries:**



*ContiGuard® represents all driving safety functions by integration of Active Safety, Passive Safety, Vehicle Surrounding Sensors, and Safety Telematics.*



### Pre-crash: preparation

Reducing the speed of collision using an emergency brake assist can decisively minimize the risk of injury. During a pre-crash situation, additional protective functions like seat belt tensioners are initiated to prepare the vehicle and its occupants for a crash.

If a crash is unavoidable, pre-crash information on the crash severity and crash type results in situation-dependent deployment of the restraint systems, in order to offer occupants a maximum of protection.

### In-crash: impact protection

To ensure the best possible protection of the occupants, situation-dependent airbag deployment, based on pre-crash information, is initiated to offer a maximum of protection.

Technologies such as rollover-sensing and crash impact sound sensing (the optimization of the airbag deployment, dependent on the structure-borne sound) play an important role, because of their swift and precise response behavior. The Emergency Brake Assist also remains active during a collision.

### Post-crash: mitigation of impact

Shortly after the primary impact, measures are taken to avoid or mitigate the secondary impact, in addition to alerting rescue services.

After the primary impact being detected by an airbag deployment, the car is autonomously decelerated to a standstill by the electronic brake system. The lifesaving "eCall" is an automatically generated emergency call.

It indicates the location of the crashed car and additionally provides the Minimum Set of Data (MSD). This is important for emergency services in order to locate vehicles, especially when an accident occurs at night, for example.

### The future with ContiGuard®

ContiGuard® offers integrated safety for all traffic participants in all phases of driving. Avoiding accidents in the first place has the highest priority.

The core competencies of ContiGuard®:

- ▶ Long-standing experience in the integration of systems and components
- ▶ Long-standing experience in Human-Machine-Interface
- ▶ A scalable safety approach for all customers, needs and markets
- ▶ Developed and engineered together with our customers and already in series production vehicles today
- ▶ Open roadmap for integrating new safety features and functionalities

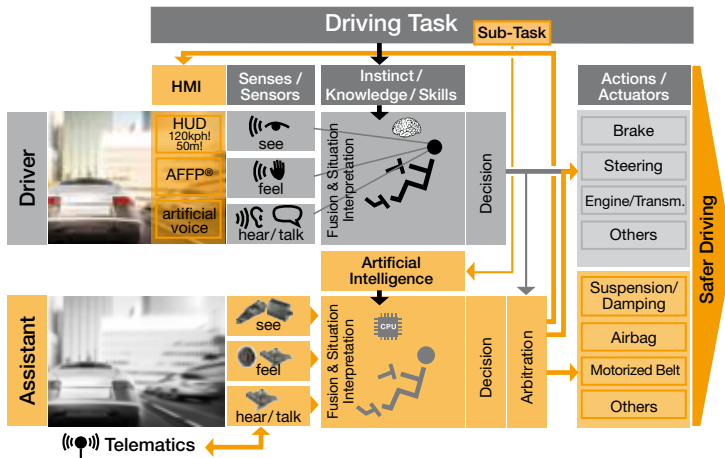
In a large number of vehicles, increasingly also in the mid-range and compact classes, individual components of the system are already in use. The incorporation of navigation data, the electronic horizon (eHorizon), and an improved driver interface, the so-called Human-Machine-Interface, are opening up new options for ContiGuard®. In particular, the inclusion of telematic functions (communication between vehicles and between vehicles and the infrastructure) opens up promising perspectives. One impressive example is the life-saving eCall function, an automatic emergency call that indicates the location and gives a time stamp and analysis of the damage.

Combining the camera sensor with distance sensors enables better evaluation of the traffic situation. By classifying other road users, image processing systems will in future also enable emergency braking intervention when approaching stationary obstacles such as traffic holdups.

### New intelligence with vehicle navigation



We are putting our know-how in the field of vehicle navigation and GPS position location to use with more than just comfort in mind. Navigation system data regarding the further course of the road, including dangerous intersections, tight curves, and physical settings that might give rise to accidents, for example with some stretches of road passing through forest, can be evaluated and used to assist the safety systems. We describe this electronic extension of the horizon as eHorizon.



### Human-Machine Interface: providing the driver with optimum information at all times

It is critically important to the driver that warning notices be presented to him in such a way that he is able to grasp them and make the right decisions intuitively. Our engineers call this the Human-Machine Interface and continue to investigate and develop new ways of keeping drivers informed in the best possible way.

# Dynamic Brakes for the Future

**Electronic brake systems from Continental – powerful, reliable, and scalable**

**Safely keeping within the lane: electronic brake systems (EBS)**

Our electronic brake systems feature outstanding capability for integration of functions and system components. They lie at the heart of our development and production of systems for safe driving and braking. The EBS category includes ABS and ESC systems including numerous additional functions and options of integration.

**Characteristics of the current electronic brake system generation:**

- ⦿ High speed valve technology of the newest generation with analog control for optimized wheel slip control functions and increased comfort
- ⦿ High pressure build-up dynamics by using a powerful pump with an optimized suction range
- ⦿ Possibility to integrate sensors for pressure, yaw rate, and acceleration, and the achievement of corresponding cost reductions
- ⦿ Powerful micro-processors that make a greater integration and networking possible
- ⦿ Optimized design with regards to space and weight



**Overview of current safety functions:**

**Anti-lock Brake System (ABS)**

In the event of an emergency braking, there is a risk that the vehicle's wheels will lock. ABS prevents this by electronically controlling the braking force so that the vehicle remains capable of steering and stable. ABS offers additional safety, especially in critical situations, and is practically standard in today's cars.

**Electronic Stability Control (ESC)**

ESC, presently the most important active safety system, prevents critical vehicle states from developing. The system constantly evaluates the data from the wheel speed sensors, the steering angle sensor, the yaw rate and lateral acceleration sensor and compares the driver's input with the vehicle's actual behavior. If an unstable state is detected, for instance as the result of a sudden direction change, ESC responds in milliseconds and stabilizes the vehicle through wheel-specific brake intervention and adjustment of the engine torque.

The ESC systems offer analog-controlled, infinitely variable valves for minimal pedal vibration and optimally dosed pressure build-up in the automatic braking process of Adaptive Cruise Control (ACC) right up to bringing the vehicle to a complete standstill in stop and go traffic.

In addition, our EBS family utilizes the ESC pump for brake boosting, among others, to avoid the increase in the pedal force in the event of brake fade, and to support the driver when there is temporarily a low engine vacuum (e. g. in the cold start phase of direct injection engines). The high-performance MK 25E/60E and MK 25A/60A systems offer all functions, from basic ESC to a high-end system with the convenience and performance features of future brake-by-wire technology.

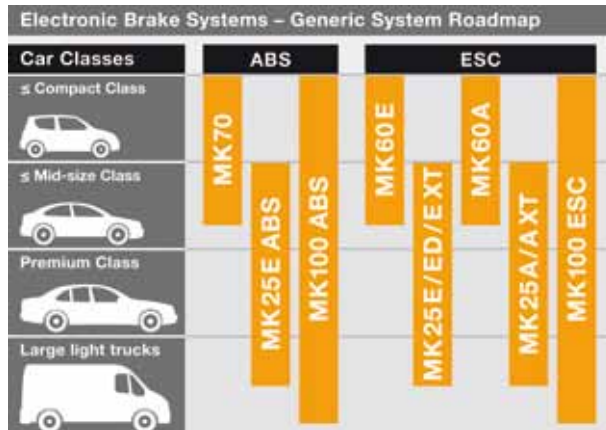
## Extended control functions of the electronic brake

### Hydraulic Brake Assist

This is a function based on existing components of the Electronic Stability Control: the brake assist function is enabled through an addition to the ESC software. In case of a panic brake situation the system recognizes that the driver is unable to build and keep up the maximum brake force required. To avoid a potential collision, the pump of the ESC system builds up pressure autonomously. As a result, the stopping distance of the vehicle is reduced significantly.

### Additional added value functions of the electronic brake

With a clear increase in comfort and safety, drivers benefit from the precise, convenient, and quiet control applied by our additional safety and assistance functions. These functions range from ARP® (Active Rollover Protection), TSA® (Trailer Stability Assist), HSA (Hill Start Assist), and FSA (Full Speed Range Adaptive Cruise Control) to complex autonomous overlay functions for vehicle stabilization. Extended control functions are pure software extensions based on existing ESC systems. This means no additional hardware component or sensor is necessary for the realization of the control function.



## MK 100® – The new generation of electronic brakes

The MK 100® is based on a modular product family and can be scaled as desired: from a motorcycle ABS, with or without an integral brake function, to high-end solutions with extremely powerful, low-pulsation pump variants. The safety and assistance functions already mentioned earlier can also be configured with the MK 100 ESC®. The MK 100® additionally represents a new dimension in installation space and weight. Dimensions and weight will be reduced by more than 30 per cent compared with the current ESC generation.

The new MK 100® goes into series production in 2011 in European and Asian platforms. Many more car manufacturers in Europe, NAFTA and Asia have also already awarded or opted for the MK 100® and will be bringing it into series production in their future vehicle platforms. The positive response by vehicle manufacturers globally therefore proves that the concept and the technology behind the MK 100® is a success.

### High level of integration ability

The new generation of the electronic brakes distinguishes itself especially by its high level of integration ability. The ESC sensors can already today be integrated on the circuit-board of the controller (PYA technology).

In future, the control of the new generation of the electric parking brake will also be integrated into the ESC which results in no separate controller being required for the triggering of the integrated parking brake (IPB). A result thereof is a minimization of the number of controllers that need to be integrated and thus an increase of available storage space in the vehicles.



MK 100® ESC

## Combination is the future – Electric Hydraulic Combi Brake

With its combination of a high-performance hydraulic brake at the front axle and an electromechanical brake at the rear axle, the Electric Hydraulic Combi Brake links proven technology with innovative functions.

### Components of the Electric Hydraulic Combi Brake system:

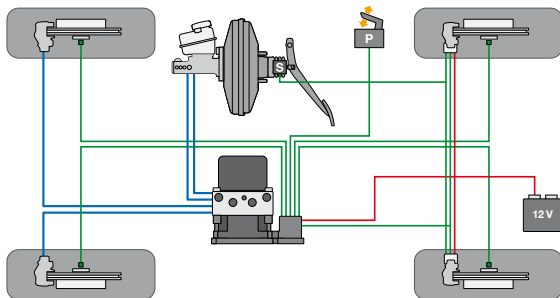
- ⦿ Downsized actuation unit and hydraulic electronic control unit
- ⦿ Down sized hydraulic electronic control unit
- ⦿ Conventional hydraulic wheel brakes at front axle
- ⦿ Electromechanical brakes with integrated parking brake at rear axle



*Electromechanical brake with integrated parking brake*

### Electric Hydraulic Combi Brake Characteristics:

- ⦿ In combination with the MK 100® ESC Hybrid, the EHCB system can also be used in vehicles with regenerative brake systems
- ⦿ Wheel brakes with reduced residual torque can be used, making a significant contribution to cutting CO<sub>2</sub> emissions
- ⦿ Use of the electromechanical brake at the rear axle leads to faster response times in safety systems such as pedestrian protection and Emergency Brake Assist
- ⦿ Fully integrated parking brake with intelligent and optimized idle concept enables a constant function chain from assisted driving to secured parking
- ⦿ Standardized components with flexible adaptation to different vehicle variants
- ⦿ No hydraulic connection to rear axle
- ⦿ Standard 12 V power system



**Electric Hydraulic Combi Brake system layout**

■ Data network ■ Hydraulic connections ■ Power supply

## Brake and recover energy at the same time – Regenerative Brake System

A pedal feel simulator with a pedal angle sensor supplements the actuation unit. When depressing the brake pedal the simulator provides optimum pedal feel, the deceleration, however, is realised through the generator. The braking energy is converted into electric power, which is used to charge the vehicle battery.

Only if the required deceleration is not sufficient, then the conventional brake system is activated. This generates the remaining braking effect based on the driving state determined by sensors for wheel speed, yaw rate, lateral acceleration, etc.

The use of a conventional ESC unit enables the Regenerative Brake System to perform all known braking interventions and stability functions (e.g. ABS, EBV, TCS, ESC, HBA, ACC, etc.)

### Benefits:

- ⦿ Full use of the energy recovery potential (serial recuperation concept)
- ⦿ Optimal for hybrid vehicles as well as electric and fuel cell vehicles
- ⦿ The basic concept and the proven components of the conventional brake are mostly retained
- ⦿ Optimum pedal feel selectable by the vehicle manufacturer
- ⦿ Low noise, almost no pedal vibrations in ABS mode
- ⦿ Improved crash behavior
- ⦿ Networking adaptability to further vehicle control systems



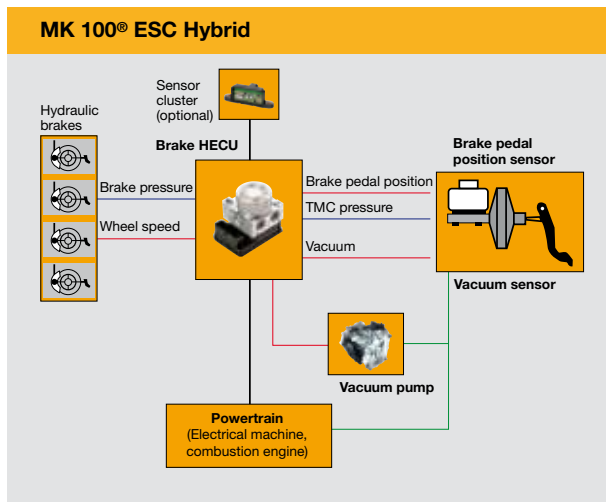
*In conjunction with a hybrid drive, the Regenerative Brake System allows energy recovery during braking.*

## MK 100® ESC Hybrid – system layout

ESC Hybrid is based on a standard hydraulic brake system. The only additional part needed is a brake pedal position sensor. When the driver depresses the brake pedal, the driver activates the hydraulic brake. Simultaneously, the pedal position sensor measures the brake pedal stroke. The brake HECU converts the brake pedal stroke into a deceleration torque and commands an electric generator to achieve the torque.

In essence, the driver simultaneously activates the conventional hydraulic brake and the electric generator based brake. The recuperation focuses on the dominant vehicle deceleration range (up to 0.2g – dependent on the availability of the generator). The driver compensates the decreasing generator torque at low vehicle speed.

To increase the recuperation efficiency, the hydraulic brake is activated only when there is a strong brake pedal thrust, whereas with normal braking the braking energy is recuperated by the generator (i.e. the eGap). The eGap takes advantage of the already existing valves in the brake HECU.



MK100® ESC Hybrid - system layout

## Safety on two wheels – Electronic Brake Systems for motorcycles

To improve the active safety of motorcycles we have developed electronic brake systems for scooters and motorcycles of all classes on the basis of our tried-and-tested passenger car ABS technology.

### Motorcycle Anti-lock Brake System (MAB)

The MAB offers improved braking control and thus greater driving safety thanks to optimum braking. The MAB's compact dimensions and light weight make it easier to integrate or "package" into the motorcycle's design. If the ABS unit only takes up a small amount of installation space, less adjustment is needed to the motorcycle's existing structures, to its frame, fuel tank, or fairings.

### Motorcycle Integral Brake Systems (MIB)

With the MIB system, both wheels can be used for braking, although the driver only activated one brake. The system recognizes the request of the driver to brake and actively builds up pressure on the other brake circuit, which results in both wheels being activated for braking.

Both systems can support the **Rear-Wheel Lift-off Protection (RLP)** functionality. It prevents lift-off of the rear wheel. In addition, the RLP function prevents the motorcycle from somersaulting through countermeasures such as moderate pressure modulation in the front brake.



ECU of an electronic brake system for motorcycles (MAB MK 2-2)

## Braking Quickly and Safely

### When every second counts

#### Continental disc brakes – high-performance in all situations

As one of the world's leading suppliers of hydraulic brake systems, Continental is constantly working on developing new and improved solutions for traditional brake technology and optimally adjusted actuation systems. Our product portfolio ranges from disc brakes, parking brakes, and drum brakes to brake hoses and brake fluids.

#### FN brake caliper

For years we have enjoyed extremely good success with our FN brake caliper. Consistent further development has allowed us to achieve constantly improved braking performance while reducing space requirements and weight. For instance, the FNR calipers permit larger brake discs to be installed for the same wheel size.

Our FN calipers offer the familiar positive features concerning their corrosion resistance. Furthermore, the weight can be significantly reduced by the use of aluminum. We remain true to our strategy to developing high-tech solutions at affordable prices. Our cost-optimized FN-L and FA-L calipers are therefore ideal for expanding markets such as Asia and Latin America, for example, and for affordable cars.

#### New generation of fixed calipers in a sporty look

Our new generation of fixed calipers combines our years of positive experience with floating and fixed caliper disc brakes.

We applied the knowledge we have gained through the further development of the FN disc brake with regard to performance, corrosion, and NVH (Noise Vibration Harshness), combined with the structural benefits of a fixed caliper, to create the new generation of fixed calipers from Continental. Stable brake structure ensures superior performance, constant high braking force, and an excellent pedal feel. Corrosion resistance is ensured by permanent freedom of movement among moving parts, and the NVH behavior of the floating caliper is also achieved in the fixed type caliper through reduced noise sensitivity thanks to trailing pads.

The new fixed type caliper has an extremely sporty look and with its appealing, eye-catching design, it is highly recognizable. The lower power-to-weight ratio contributes to reducing CO<sub>2</sub> emissions and enhancing fuel economy.

The fixed type caliper is easily scalable as a combination in various sizes.



#### FA brake caliper (Pinslider)

With the FA-Pinslider, the brake housing is positioned exactly at the brake pads and discs through the service-free anchor guides. The brake pads are axially mounted to the brake disc with low frictional resistance. The function offers a high level of comfort and includes a reduced and parallel pad wear, reduced residual brake torque and a low noise and brake judder.

#### Parking brake systems

Parking at the push of a button or with a traditional manual lever – our customers have the choice.

#### Conventional parking brakes

#### Duo-servo brakes

A highly efficient, self-boosting drum brake, fitted in the brake disc hat. It is operated mechanically and is completely separate from the service brake. Its main field of application is premium-class vehicles and SUVs.

#### Combined caliper

The combination of service brake and parking brake in the classic FN or pinslider design is a cost-optimized solution for vehicles in the lower and upper mid-size class.

## Electronic Parking Brake Systems

In addition to stopping the vehicle, the second important function of a vehicle's brakes is to hold the vehicle in place and keep it from rolling. The advantages of an electronic parking brake include various assistance functions for greater safety and comfort. The electronic parking brake also offers various options for design of the vehicle's interior, since there is no parking brake lever.

We offer two different EPB system solutions for the full spectrum of customer requirements:

### EPB-CI

The combined caliper with integrated actuation is controlled by a stand-alone control unit or a controller already available in the vehicle (e.g. ESC).



*Electrically actuated combined caliper of the EPB-CI*

### EPB-DSe

This system consists of a central control unit and two electro-mechanically actuated duo-servo brakes.

#### Shared advantages of all our EPB systems:

- ◊ Simple operation at the touch of a button
- ◊ Emergency brake function in the event of service brake failure
- ◊ Implementation of various assistance functions for safety and comfort in conjunction with the EBS



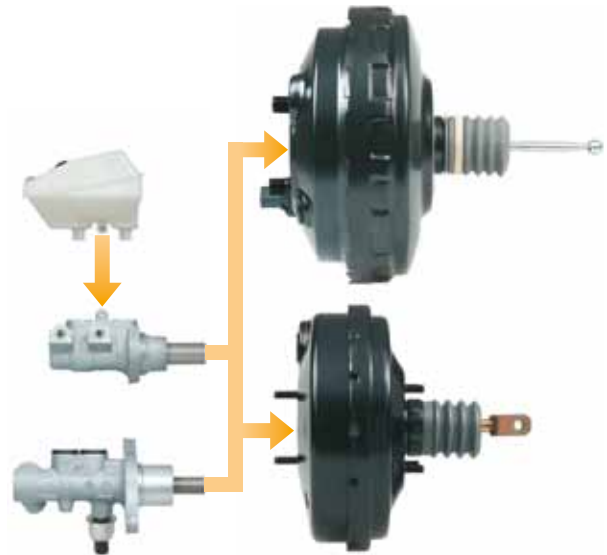
*Electrically direct actuated duo-servo brake of the EPB-DSe*

## Brake actuation and brake assistance systems

We offer customer-specific, robust and attractively priced brake actuation systems from our modular concept. All actuation components originate from our modular system and can be individually combined with each other as needed:

- ◊ Brake booster
- ◊ Tandem master cylinder
- ◊ Brake fluid reservoir
- ◊ Pressure regulating valve
- ◊ Additional functions, such as for crash optimization or applied sensorics

This freedom to combine units enables us to implement individual solutions for vehicles of all classes and for all markets, including low-cost and light-weight solutions, without having to invest in costly tools each time. This can make a significant contribution towards reducing both CO<sub>2</sub> emissions and costs. The availability of standard components also significantly reduces development time.



*Optimized actuation systems that suit vehicles of all classes, assembled from the components of our modular system: 6 sizes of single boosters, 7 sizes of tandem boosters, 2 TMC types and application-specific designed reservoirs.*

## **The international benchmark in high performance: our brake actuation components**

### **Brake boosters**

We supply vacuum brake boosters in both single and tandem design, in all required sizes. All product variants are available in conventional steel, but also in lightweight aluminum housing versions. The tie rod version, available for all designs, features further weight reduction and also optimized deflection characteristics. Frontbolt designs on a tie rod basis simplify assembly at the OEM.

The latest brake booster generation (Booster Gen. III) features further weight reduction (full aluminum with reduced wall thickness) and an ultrashort installation length.

### **Tandem master cylinders (TMCs)**

We offer TMCs both in central valve design and in the highly compact plunger design for all required diameters and strokes as well as for various types of brake circuit designs (straight or stepped bore).

### **Brake fluid reservoirs**

We design reservoirs specifically for each vehicle application, but use standardized sub-assemblies such as filler caps and fluid level indicators as much as possible.

### **Affordable products for the expanding markets of the world**

With our modular designed products we are in a position to meet all customer requirements, also those in low-cost markets. This includes the ABA brake booster (Affordable Brake Actuation) and the compensation bore (SL) tandem master cylinder for ABS applications.

### **Brake assist systems**

Danger detected – braking force boosted: brake assist systems ensure maximum vehicle deceleration in emergencies, even when little force is exerted on the pedal.

Brake assistants are important helpers in emergencies in which the driver does react fast, but does not brake energetically enough, leading to dangerously long stopping distances. The brake assist detects panic situations based on the speed at which the pedal is depressed and activates the booster or

the EBS hydraulic unit. This means that even when little force is exerted on the pedal, the vehicle achieves maximum deceleration. We offer two technologies to accomplish this:

### **Mechanical brake assistant**

In this system, a mechanism uses the effect of inertia to recognize high brake pedal speed combined with heavy pressure exerted by the driver's foot. The driver's wish for greater deceleration is supported through activation of the brake booster, supplying maximum boosting.

### **Electronic brake assistant**

This solution utilizes a vacuum brake booster with an electronic brake assist function and pedal travel sensor and a standard ABS-TMC interface. This multifunctional module is also used in ESC systems and Adaptive Cruise Control (ACC).

### **Electric vacuum pump (EVP)**

The EVP is able to cover all vacuum requirements – especially in electric, hybrid, and diesel-powered vehicles as well as in gasoline direct injected engines. Furthermore, the EVP is used if the internal combustion engine on modern vehicles does not produce a sufficient vacuum to operate the brake booster and vacuum-controlled actuators.

The robust, durable design of the EVP makes it possible to use the EVP as the only source of vacuum in the vehicle. With "vacuum on demand" functionality independent of the powertrain, the EVP contributes to reducing the CO<sub>2</sub> emissions of conventional combustion engines.





### Proven safety for emerging markets: drum brakes

Drum brakes are radial brakes with two brake shoes that are typically pressed outward against the friction surface of the drum through hydraulic wheel cylinder actuation in service braking and through the lever in parking braking. When braking ends, springs pull the brake shoes back inward. Drum brakes are a good combination of service braking and parking braking and have advantages in residual torque and cost.

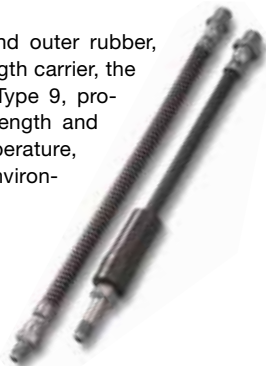
We offer a variety of different drum brakes in the well-known simplex design. These types of brakes are suitable from entry level vehicles up to light commercial vehicles.

### Brake hoses – experience counts

With a production output of around 40 million brake hoses a year for the automotive industry, Continental is one of the world's market leaders in this segment.

### Type 9 – our current technology

With a composite of EPDM inner and outer rubber, plus a double-layered PVA high-strength carrier, the current generation of brake hoses, Type 9, provides a maximum in mechanical strength and optimum resistance to pressure, temperature, chemicals, oils, fuels, and other environmental influences.



## At the Pulse of the Vehicle

### Innovative sensors for electronically controlled functions

In the field of automotive technology, sensors are specified and optimized for a specific application. Our sensors are part of an overall system, in which they perform important measurement tasks in order to determine the vehicle's status in terms of that specific application. Wherever performance, reliability, comfort, and safety are required, our sensors are leading edge on a worldwide basis. We focus on a number of requirements in our development and production activities:

- Low manufacturing costs
- High level of reliability
- Robust to withstand extreme operating conditions
- Small design
- High level of measurement precision

With our product portfolio we are well-positioned to cope with the steadily rising proportion of vehicle functions that are controlled electronically and also with their increasing requirements. Mechatronic integration of sensors is becoming more and more important, with mechanical, electronic, and data processing functions being integrated together. In the future, there will be an increasing number of sensors with standardized, flexible, and bus-capable interfaces. Self-diagnosis and multiple sensor uses via the signals on the data bus are major innovation drivers.

### Sensors for active safety systems: ABS, TCS and ESC

Our sensors are of essential importance for the operation of electronic vehicle control systems: the rapid and precise measurement of rotational speed, movements, acceleration, rotation rates and forces which act upon the vehicle is perfectly performed. We develop and produce the technologies to implement the transducers, along with the hardware and software which is necessary for our sensors ourselves. The development goals are thereby derived from the requirements of the electronic control systems for ABS, TCS and ESC.

## Active wheel speed sensors

The control systems for ABS, TCS and ESC determine the wheel speed based on signals sent by the wheel speed sensors. This information is used to prevent the wheels from locking and determine when the wheels are spinning, taking appropriate control action to maintain the vehicle's stability and steering responses.

Wheel speed is measured using the anisotropic magnetoresistance (AMR) effect. This method and the integrated information processing feature enable our latest generation of sensors to handle the following functions:

- ⦿ Measurement of rotational speed (even at low vehicle speed)
- ⦿ Air gap measurement
- ⦿ Dependable functionality with large air gaps (up to 4.5 mm between sensor and encoder)
- ⦿ Standardized VDA data protocol
- ⦿ High resistance to extreme temperatures, from -40°C to +150°C
- ⦿ Internal signal monitoring



*Mini speed sensor: element before being injection-molded in plastic to a finished wheel speed sensor*

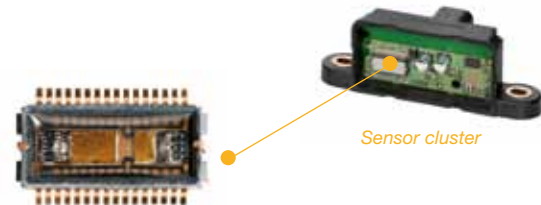
The latest generation of our wheel speed sensors is the "Mini Speed Sensor." This completely new development stands out especially for the fact that all of the functional components, including the AMR bridge, ASIC and magnet are integrated into a housing just 3.2 mm in size, and the fact that despite these small measurements, the sensor can easily be inserted into a mold and injection-molded in plastic. The process of injection molding using a thermoplastic synthetic material creates the exterior shape required for the specific application. The new "Mini Speed Sensor's" tiny size offers vehicle manufacturers greater flexibility in choosing an installation location within the vehicle, and with its cost-optimized design, the Mini Speed Sensor will take on an important role in production of affordable cars.

## The essential features of the new wheel speed sensor are:

- ⦿ High reliability and robustness due to the use of AMR technology
- ⦿ Enhanced resistance to thermomechanical strain
- ⦿ Compatibility with today's series-produced sensors (interchangeable if air gap is comparable)
- ⦿ Small installation space for future applications
- ⦿ Low operating voltage (goal: < 4.5 V)
- ⦿ Air gap measurement during customer's installation process

## Sensor cluster

The sensor cluster provides all control units in the vehicle with the vehicle's current movement status (yaw rate, longitudinal and lateral acceleration and, optionally, pitch and roll rates) in the form of electronic signals. The verified signals are transmitted to the data bus via a standardized interface, which can also be adjusted on a customer-specific basis. In complex control algorithms, these signals are used to initiate vehicle stabilization when ESC control is activated. The signals are also needed for driver assistance systems.



*Combo sensor*

One of our core competencies lies in processing of microelectromechanical system (MEMS) signals and making adjustments to the mounting location in terms of vibrations and temperature. Our use of the latest technologies for MEMS elements and ASICs enables a high level of component integration and compact design. With its fully developed technology, low application costs, and low complexity, the sensor cluster is an ideal product for existing and future vehicle platforms.

Derivatives of the standard sensor cluster for the Continental ESC in passenger cars have the following applications:

- Sensor cluster with customer-specific interface for applications in external systems
- Redundant sensor cluster for high safety requirements regarding the control system (SIL3)
- Sensor cluster for ESC applications in the truck market with freely programmable MCU
- Sensor box to measure the tilt angle during motorcycle operation
- Sensor cluster with several degrees of freedom for the industrial sector as a catalog part with a J1939 interface

An innovation in inertial measurement technology is the measurement of the yaw rate and the acceleration in a single component (Combo-2 Sensor). The integration in one housing includes the MEMS elements for measurement of the acceleration and the yaw rate, and the corresponding combi ASIC for signal processing. Due to its compact design as an SMD component, and the capability of adapting the calibration flexibly to the relevant requirements, the Combo Sensor is used not only in sensor clusters, but also in other control devices. The introduction of this innovation enables manufacturers to considerably reduce the size of all electronic devices that measure yaw rates and acceleration.

### Steering angle sensors

Steering angle sensors measure the rotation angle, angle velocity and direction of the steering wheel, providing information on the direction in which the driver wishes to go. Steering angle sensors are required for systems such as ESC and are also used in electric power steering and active steering systems (EPS or AFS) as well as parking assistance systems and curve lights.

**The steering angle sensor from Continental has the following characteristics:**

- Magnetic angle measurement using AMR sensors,  $\pm 720^\circ$  (four revolutions)
- Absolute angle measurement
- True Power On (TPO)
- Stand-alone sensor

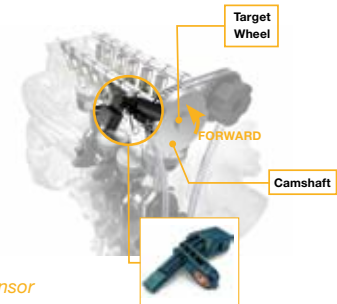


*Steering angle sensor: stand-alone sensor application*

### Engine and transmission rotational speed sensors

For the engine management, speed and position sensors (so called phase sensor) provide information on the exact position of the crankshaft or camshaft.

This information provides the basis for the modern engine control for the regulation of ignition and injection times, and the fresh gas and exhaust gas regulation. In addition to observing legal exhaust gas levels, this also ensures optimization of the engine performance, a reduction in fuel consumption and improved running smoothness.



*Active Camshaft Sensor*

Modern speed and position sensors must in this case comply with the increasing requirements with regard to rapid engine synchronization and fast, optimized starting (Stop-&-Start).

**The essential characteristics of the engine speed and position sensors are:**

- Determination of the turning speed of the engine (speed of the target wheel)
- Determination of the exact position of the crankshaft/camshaft = piston position (electronic mapping of the target wheel position)

**The main functions of modern engine speed and position sensors include:**

- "True Power on" (camshaft) and "direction sensing" (crankshaft) respectively
- Axial or radial reading
- Use of "self-learning" IC ("optimization" of the signal precision by the "adaptive" reading of the target wheel profile)
- Very high level of precision ( $\pm 1^\circ$  typical) and reliability of the signal (repetition accuracy)
- High temperature resistance ( $-40$  to  $+150^\circ\text{C}$ )/vibration resistance

On a manual transmission, the speed sensor captures the vehicle speed on the gearbox and provides this information to the speedometer. In the case of automated transmissions (step automated transmission, continuous variable transmission, dual-clutch transmission or automated manual transmission), one to three sensors are mounted in the gearbox delivering the input, or output, or the intermediate gear speed to the transmission control unit (TCU), responsible for managing the whole system.

### Sensors for electric steering

Power steering typically comes standard even in the compact car segment. To implement this form of electronic control, a torque sensor is required on the torsion bar of the steering unit.

#### Torque sensors

A torque sensor measures the force expended in a steering actuation and the direction in which the driver steers. The electronic components of electric power steering (EPS) use this information to calculate the support provided by the electric motor. The torque sensor from Continental is based on a relative angle measurement on the torsion bar of the steering unit. The sensor is designed to be rotationally symmetrical, and its patented technology eliminates the need for a coil spring. The stringent safety requirements that apply to steering also require redundant design of the sensor.



*Torque sensor: integrated on the torsion bar of the steering system*

- Non-contacting torque measurement using Hall sensors
- Robust magnetic measurement principle
- Flexible construction (customer-specific)
- Compact alignment of sensor components (axial and radial)
- Standalone sensor

### Sensors for active chassis control systems

Active chassis control systems require sensors to measure the distance between the suspension and the chassis. To determine the acceleration of the body and wheels in the case of regulated shock absorber systems, acceleration sensors measure the wheel and body acceleration in the direction of the vehicle's vertical axis. Controlled, active shock absorbers are used in an attempt to further alleviate the traditional conflict of goals between sporty and comfortable chassis tuning. These

kinds of systems generally exert control using four wheel path sensors and three low-g acceleration sensors. The system control unit uses these incoming signals and additional information to determine vehicle status. When a control strategy is preset, the information is used to calculate the optimum shock absorption force for each wheel and set to that amount in the damper valve via the electrical control system.

### Continental offers the sensors necessary for the implementation of these functions:

- A position or height level sensor (CPS series), designed as an angle sensor and
- an acceleration sensor with vertical measurement direction (BSZ series, measurement range  $\pm 1.33g$  to  $\pm 15g$ ).
- BSZ4 with analog, BSZ5D with digital output

In the case of the CPS, installation within the vehicle takes place by means of customer-specific lever constructions. The BSZ acceleration sensors are distributed throughout the vehicle such that a virtual plane is established. Rigid body motion within this plane is taken as the measurement for the movement of the vehicle's body.

#### Additional fields for the CPS are:

- Headlight range and level control
- Angle measurements in vehicles (e.g., dump trucks, construction and agricultural machines)

#### Additional fields of application for BSZ sensors:

- Active damping systems for engine mountings
- Rear flap control systems
- Incline sensors for motorcycles, passenger cars, trucks, and construction and agricultural machines
- Vibration measurement in systems for the active engine bearing, or for preventive maintenance and service in vehicles



*Low-g sensor*



*Position or level sensor (CPS)*

### Angle and linear path sensors for future brake systems

Hybrid vehicles and electric vehicles make use of sensors that were developed for advanced braking systems. In this case, the condition of regenerative braking plays an important role in stopping the vehicle. To implement this function, the hybrid or electric vehicle must detect the driver's braking intention electronically at the brake pedal and send a signal to that effect to the control unit. This can take place, for example, via an angle sensor mounted on the brake pedal. Another possibility is to measure the path traveled by the piston rod in the brake master cylinder.

The Linear Position Sensor (LPAS) concept is a best-cost alternative for future brake systems. This approach is modular and flexible and can be adjusted to meet customer requirements.



Example of a LPAS sensor

### From sensor to sensor systems

In today's design of E/E (electric/electronic) vehicle architectures, sensors are typically allocated to specific functions, such as the electronic stability program, power steering, or navigation. That means that when new functions are introduced, the same sensors are installed redundantly.

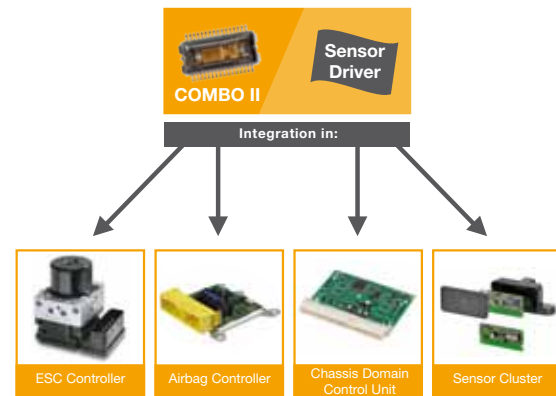
As part of our ContiGuard® activities, the Chassis and Safety Division is developing a new approach to E/E architecture that takes sensor allocation into account. The central task here is the fusion of different driving dynamic sensor signals such as rotation rate and acceleration sensors, and also detection of the driver's intentions such as steering angle sensors in a virtual software node.

These nodes prepare the signals they receive and provide them to as many functions as possible, across a range of different domains. Some of the signals can be used in different ways to calculate the same measurement variables (virtual sensors); one well-known example of this is dead reckoning.

Merging and reconciling the signals makes it possible to achieve both an improvement in precision and mutual monitoring and support among the signals in the event that one signal is lost. The goal is to assign an integrity figure to every measurement value that is output to provide information about that value's precision and reliability. This software node, including the sensor hardware, can be implemented in a new control unit, or in existing ones, such as the airbag control unit, the hydraulic/electronic control unit, or a general functional control unit.

The focus lies initially in the development of a so-called sensor-vehicle function matrix, in order to detect the various sensor signals required and their requirements, and to organise them into scalable software modules. This also allows the elimination of redundant sensors, and the addition of new functions to the standardised sensor information with a lower development requirement. In a further step, new sensor signals such as GPS or those of the "Speed Over Ground Sensor" are processed. Sensor information relevant to safety from other vehicles or service-providers can also be integrated via the so-called Car-2-X communication (car-to-car, car-to-infrastructure, etc.) in an extended node module, in order to enable driver assistant functions more cost-effectively.

A first step toward flexible sensor nodes is being taken in cooperation with all business units. The "Sensor System Inertial" project is developing a software component for the processing of longitudinal and lateral acceleration as well as yaw rate, which can then be implemented flexibly in various control units.



# Passive Safety and Driver Assistance

## Protective technologies for complex driving situations

Driver assistance systems, passive and active safety technologies lead to a considerably improved level of vehicle safety. However, only when active and passive safety interact can a comprehensive and predictive image of the current traffic situation be generated, enabling better activation of all the available protective measures.

## Intelligent Passive Safety Technologies: best possible protection for everyone

We develop safety electronics that considerably reduce the risk of accidents and related injuries to vehicle occupants and other road users. These include:

- ▶ Airbag control units/Safety Controllers
- ▶ Crash sensors for front, side and rear-end impacts
- ▶ Driving dynamics and rollover sensing
- ▶ Sensors for active pedestrian protection systems
- ▶ Sensors for electric vehicles (high-voltage battery cut-off)

We offer individual, customer-specific and application-specific solutions for all vehicle classes, from small compact cars to off-road vehicles.

## Efficient, flexible, and affordably priced – control units on a modular basis: SPEED (Safety Platform for Efficient & Economical Design)

The automotive markets around the world vary considerably. While vehicles for European or North American buyers are equipped with a large number of airbags, the safety equipment in other parts of the world is often limited to the driver's airbag. With SPEED, we have developed a control unit that is based on a modular structure and can be adjusted easily to the wishes of car manufacturers. The scalable SPEED concept covers the needs of all markets worldwide. And that also applies to the requirements for the various vehicle classes and sizes.

## From Airbag Control Unit to Safety Controller

Continental's new generation of passive safety improvements will enhance the safety of vehicle occupants and pedestrians. By assessing data from the Electronic Stability Control (ESC) and by incorporating innovative radar or camera sensors from driver assistance systems into passive safety controls, it becomes possible to recognize an imminent accident earlier and thus better assess the severity of the accident.



Control units SPEED M and SPEED XS

The integration of classic crash detection with technologies from driver assistance systems presents passive safety systems with completely new possibilities of recognizing critical situations as such, before an accident actually occurs and can therefore react more quickly. As a result, vehicle occupants and pedestrians can be even better protected.

### Benefits of SPEED:

- ▶ Flexibility and cost optimization through modular building blocks
- ▶ 100% fulfillment of customer specific requirements
- ▶ Fast development times and marketability
- ▶ Worldwide standards in quality, reliability and safety
- ▶ Extendable functionalities, e.g. sensor cluster integration

### Decentralized Crash Sensors Provide All-around Protection – our Acceleration and Pressure Satellites

A big step forward toward comprehensive safety, all thanks to a small, inconspicuous piece of electronics: intelligent crash sensors are the perfect complement to the SPEED control unit in a crash.



*Acceleration satellite gSAT*

Take a frontal collision, for example. In this case, the well established acceleration satellites gSAT deliver that additional plus in support. They measure and supply the information on the acceleration values in the rigid vehicle structures to the control unit in the event of a crash. SPEED can determine both – the duration of intrusion and the intensity of the crash – and activate lifesaving restraint systems in just milliseconds.

### Quick Reaction to Side Crashes

Our pSAT pressure satellites, which have put Continental at the forefront of the world market since 1996, were developed specifically for side crashes. Substantially faster reaction times are required for the deployment of the side airbags because the system has to fire the lifesaving airbags within just five to ten milliseconds. In addition, vehicle crumple zones offer hardly any protection for the occupants in side crashes compared to frontal collisions. Here the pressure satellite delivers excellent results also in situations such as pole crashes in which the vehicle suffers a side impact with a narrow obstacle or when the vehicle is hit by a raised bumper as is the case with many sports utility vehicles (SUVs).

The clipSAT pressure satellite moreover, offers cost and time advantages in terms of installation: without any need for additional tools or fasteners, the clipSAT can be pressed into place in the counterpart on the door with just a single motion, thanks to a novel mechanical concept.

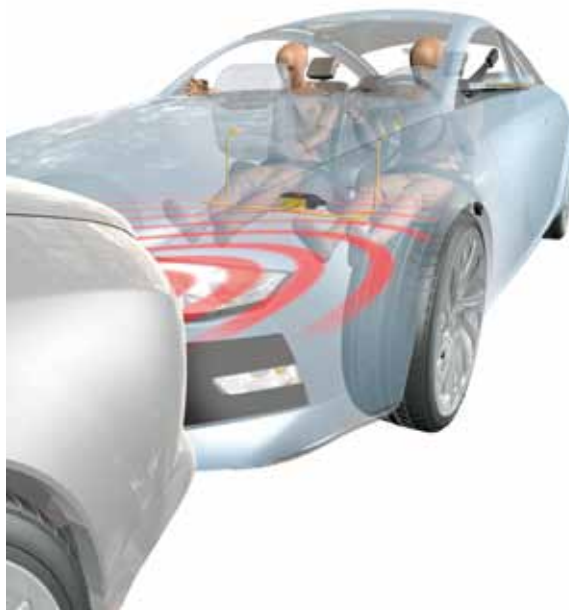
*Time and cost advantages in terms of installation: clipSAT*

### A Faster Way to Determine Accident Severity – Crash Impact Sound Sensor

When an accident occurs, the airbag safety system has to decide in split seconds what needs to be done: was the impact so strong that the airbags need to be deployed? Or are the airbags not needed at all, meaning that the other elements of passive safety, such as crumple zones and safety belts, are sufficient? The analysis of how severe the crash will actually be has to take place in fractions of a second.

The crash impact sound sensor detects the accident and determines its severity from the characteristic sound of the collision with the vehicle's body, a sound that travels at up to five meters per millisecond. Every material makes a specific sound in the event of deformation. Different accidents thus yield varying signals. Crash impact sound sensing can dependably categorize the crash situation and provides crucial time savings: a danger warning is transmitted to the airbag control unit up to 15 milliseconds earlier than with conventional systems. The restraint systems are therefore activated more quickly, resulting in vehicle occupants being considerably better protected.

Another plus: crash impact sound sensing technology can be integrated into the SPEED control unit – a cost advantage paired with markedly improved performance capacity.



### Pedestrian Protection: an Innovative Pressure Sensor Recognizes Impact

Pedestrians don't have any crush zones; that puts them at particular risk. Continental's pedestrian protection system reduces the risk of head injury in the event of a collision. Within 10-15 milliseconds of an impact, the active hood of the vehicle is triggered and raised by special actuators. This reduces the risk of death or severe injury to the pedestrian from hitting the hood and underlying engine block.

The crash sensor consists of an air hose that is laid across the entire width of the car in its front bumper. The hose is therefore situated directly behind the foam block that is fitted at the front of the vehicle to absorb energy. Standardized pressure sensors (pSAT) are installed at either end of the air-filled pressure hose. When a vehicle collides with an obstacle, the resulting pressure exerted on the hose through the front bumper and foam block creates a typical waveform that is detected by the two sensors at the ends of the hose and forwarded to the SPEED control unit.

#### Benefits:

- 🔸 Rapid recognition of every required pedestrian impact situation
- 🔸 Excellent robustness
- 🔸 Easy to integrate and cost-optimized design
- 🔸 Redundant system for maximum safety



*Pedestrian protection system based on pressure sensing PPS pSAT*

### Our safety contribution towards electric mobility: evSAT – sensor for high-voltage battery cut-off



“evSAT” stands for “Satellite for Electric Vehicles” and essentially consists of an independent, triaxial sensor with a CAN interface. During the charge phase, the other vehicle electronics, including the airbag system are not operational.

Then this acceleration sensor employs an algorithm to detect a frontal, rear or side collision with another vehicle and immediately transmits a signal via the CAN interface to the battery management system which then switches off the battery within half a second.

In the event of an accident during normal driving mode the airbag system assumes the task of cutting off the battery. If the electric or plug-in hybrid vehicle has been switched off and is not being charged, the evSAT moves to a standby mode to prevent the battery discharging. evSAT therefore represents an additional passive safety system function for electric and plug-in hybrid vehicles.

### We possess the best prerequisites for the development of safety architectures

We own one of the largest independent development centers in the field of vehicle safety in Europe. A team is based here that has approx. 20 years experience on working on groundbreaking systems and applications from mass production to derivatives and from sports cars to the smallest compact vehicles.

From full restraint system development to resident engineering and operator models, or simple provision of services, we are responsible for developing vehicle safety throughout the entire vehicle development process.

## Driver Assistance Systems Help Save Lives

**Advanced Driver Assistance Systems provide drivers and passengers with additional safety, an increase in comfort and protect the environment**

Driver assistance systems make road traffic on the whole safer and ensure that the driver is relaxed when he reaches his destination. They act in the background, either as individual functions or as an integrated system: with sensors for the surrounding area – camera, infrared, or radar – they look ahead and ensure a maximum level of safety. As soon as a danger is detected, they assist the driver with everything from warnings to interventions in driving. They play a decisive role in avoiding accidents and therefore help to save lives.

### Driver Assistance Systems avoid rear-end collisions

Integrated in the ContiGuard® concept, forward-looking driver assistance systems can considerably reduce stopping distance. Should it still come to a crash the severity will be significantly reduced.

### Emergency Brake Assist

Rear-end collisions mostly occur in urban areas. The Emergency Brake Assist-City has been developed precisely for this scenario and can prevent accidents with speeds of up to 15 km/h. Thanks to their favorable cost-benefit ratio, emergency braking assistant functions with our SRL sensor, along with ABS and ESC, are well on their way to becoming established as another standard active safety element in vehicles in the mid-size class, and soon also in compact cars.

With the ARS 300, we have designed a radar unit for emergency braking assistant functions for passenger cars and trucks that triggers the full braking deceleration if a crash is unavoidable. In the case of a truck, this can prevent an accident with speed differences of up to 70 km/h. This has recently also become possible for trucks approaching the end of a traffic hold up or stationary targets.

*The Short Range Lidar (SRL) is fitted behind the windshield and monitors the traffic ahead. With its "Emergency Brake Assist-City" functionality it can avoid rear-end collisions.*



The forward-looking emergency braking assistant responds by activating an automatic braking system as soon as the driver's own vehicle comes within a dangerous distance from a preceding vehicle if the driver does not respond appropriately. As a result, it can considerably reduce stopping distance. At higher speeds, emergency brake assist systems can save lives.

Benefits:

- Reduced risk of accidents
- Significant reduction in stopping distance

### Adaptive Cruise Control

Adaptive Cruise Control (ACC) is a function to increase driver comfort, especially when following traffic. To accomplish this, sensors continuously observe the vehicle's surroundings, monitoring traffic in front of the vehicle. As opposed to traditional cruise control functions, Adaptive Cruise Control makes it possible to adjust the following distance without the driver having to intervene, even in Stop & Go traffic.

New ACC systems also warn the driver promptly before possible rear-end collisions. When there is an immediate danger of collision it can precondition the brakes and if necessary trigger an emergency stop. Its goal is to shorten the stopping distance enough to save lives.



Benefits:

- Stress-free, comfortable driving with the flow of traffic, e.g., on sections of road where speeds are restricted, in heavy traffic, and even in traffic holdups
- ACC is a real support for the driver on the daily route to work
- Significant reduction in stopping distance

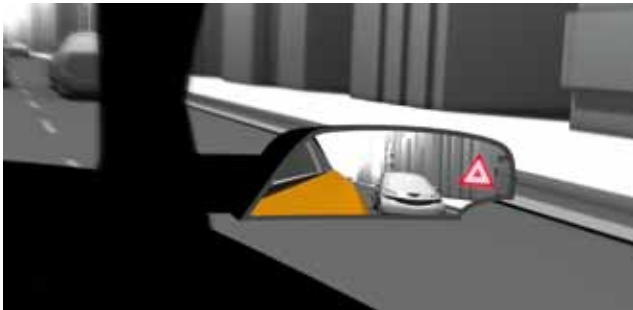
## Blind Spot Detection

This function warns the driver when there are vehicles in the blind spot of the side-view mirror. This makes traffic situations such as overtaking and lane changes much safer and more comfortable, both in the city and on the highway.

This function is highly popular in the United States in particular, as shown by high equipment figures. In the future, the radar sensors will provide additional functions, such as supporting the driver when maneuvering in and out of a parking slot.

Benefits:

- 🟡 No longer overlook anything in the blind spot
- 🟡 Changing lanes is safer and more relaxed



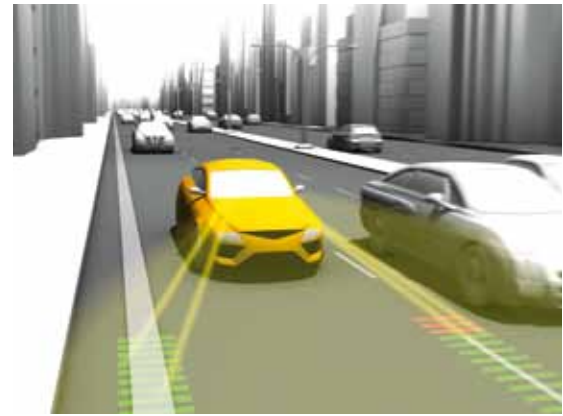
## Traffic Sign Recognition

Traffic Sign Recognition ensures that the current speed limit is displayed for the driver within his direct vision on an ongoing basis. Automatic recognition functions through images captured by the driver assistance camera. If a built-in navigation system is available, the camera is linked to the speed limit information from the navigation system.

Traffic Sign Recognition is constantly undergoing further development. Along with speed limits, these functions can now also show the driver when overtaking is prohibited and when the driver is free to overtake again. Other helpful information for the driver will follow, since development of these traffic sign recognition systems is still in the early stages.

Benefits:

- 🟡 Easy way to avoid speeding
- 🟡 Overall, safer and less stressful driving, because one is always well informed



## Lane Departure Warning

Lane Departure Warning (LDW) provides the driver with acoustic or haptic warnings, such as steering wheel vibration, protecting him from inadvertently changing lanes. Newest developments in the human-machine-interface design make the system even more effective by reducing the reaction time of the driver – because every second counts when the car inadvertently leaves the lane. This is made possible through a gentle intervention in the steering which guides the car back into the correct lane.

Benefits:

- 🟡 Prevents dangerous situations due to inattention or micro sleep
- 🟡 The system's intervention in the steering system gains additional seconds, which can save lives

## Intelligent Headlamp Control

Intelligent Headlamp Control enables better night vision. The camera of the driver assistance system controls the headlamps to ensure that oncoming vehicles and those traveling ahead of the driver's vehicle are not blinded, while at the same time providing optimum lighting of the road. The result is a seamless change between high and normal beams.

Benefit:

- 🟡 Safer, more relaxed driving through optimized night vision

## Components for a Superior Chassis

**We offer solutions for electronic-based active chassis technology which optimally adapts to any individual driving situation.**

Our chassis components support the driver in keeping the vehicle under control in all driving situations while at the same time still enjoying a comfortable driving feel. They cover a wide range, from controlling the active chassis to the Chassis Domain Control Unit. Electric steering systems make it possible to control the vehicle precisely and efficiently in any driving situation. We also support the driver with intelligent cleaning systems for clean headlamps and windshields, no matter what the weather.

### Chassis Domain Control Unit

As a control unit, the Chassis Domain Control Unit can play a central part in ContiGuard® when it comes to taking over the integration of electronic chassis components and safety systems.



*The Chassis Domain Control Unit coordinates all: an intelligent system for integrating the potentials of systems that previously operated in isolation.*

It thereby reduces the complexity of vehicle electronics through the integration of systems that have until now operated in isolation. The centralized coordination results in a harmonization of the simultaneous intervention of different systems with each other in an optimal way.

### Accelerator Force Feedback Pedal (AFFP™)

The Accelerator Force Feedback Pedal is an active accelerator with integrated electric motor which provides the driver with a haptic feedback when a traffic situation requires the driver to either take his foot slightly off the accelerator or in order to inform him to shift up a gear. As an additional benefit, AFFP™ also warns in a hazardous situation and provides an



*The Accelerator Force Feedback Pedal (AFFP™): the accelerator that communicates with the driver.*

immediate feedback to the foot of the driver, which the driver is more susceptible to than acoustic or visual warnings. The AFFP™ is integrated with a driver assistance system, and as a Human-Machine-Interface is a sensible addition when, due to inattentiveness, the primary measures for safety cannot be adequately complied with.

### Dynamic Body Roll Stabilization

We are developing the Dynamic Body Roll Stabilization together with the Schaeffler Group. Continental supplies the control electronics for it. This system reduces body roll of the vehicle and enhances the lateral vehicle stability when cornering. The major components of the next generation are a motor, a gear as well as control electronics. The advantages of the dynamic body roll stabilization are a more agile and safer ride with an accurate steering response, especially in curves. In addition, the overall ride comfort is considerably improved.

#### Characteristics:

- Reduction of body roll when cornering
- Higher level of agility and cornering stability of the vehicle
- Supports neutral self-steering characteristics



*Dynamic Roll Stabilization*

## Air suspension systems

Air suspension systems automatically adapt damping and spring characteristics, along with the vehicle's body level, to changing driving conditions and load changes. As a result, rolling and pitching movements and wheel load fluctuations are substantially reduced.



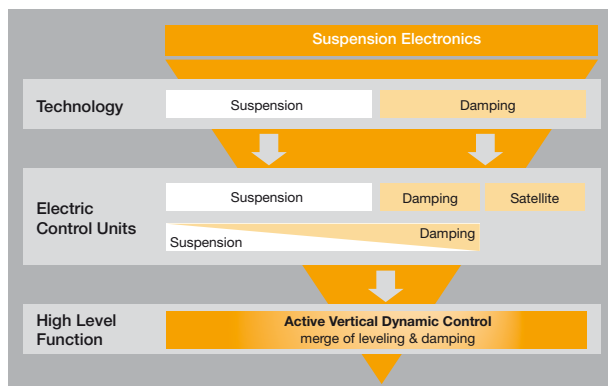
Adaptable, fast-reacting and resilient: air suspension systems derive their enormous efficiency from the interaction between sensors, electronics, and mechanics. In conjunction with the integration of ESC, a ContiGuard® function is realized which ensures a precisely aligned reaction of the shock absorbers, the suspension, the engine control, and the braking system – especially in critical situations.

Stability, optimum road grip, and adaptation to different weight loading provide not only additional driving comfort, but also an enhanced level of safety. We supply electronic air suspension systems including scalable compressors, valve block, control unit, sensors and software.

*Air suspension systems automatically adapt damping and spring characteristics to changing driving conditions.*

## Systems for vertical dynamics

Well-adjusted, rapid control of the damping function is essential to maintaining ideal vehicle position and is thus a fundamental precondition for establishing the highest level of safety. Tires, as well, must grip the ground firmly at all times. With active damping and leveling, the suspension system adjusts to



the road and driving conditions within milliseconds. Thus intelligent damping and leveling increases the vehicle's comfort in every driving situation.

The goal of this networking concept is to control and regulate the systems within an electronic architecture. Our platform concept provides the automotive industry with the benefits of reducing the number of control units. Communication takes place via interfaces such as CAN, FlexRay and AUTOSAR-compliant software. The automotive manufacturer's software can also be integrated into the system.

## Electric Power Steering



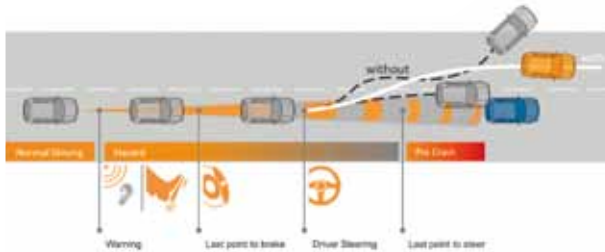
The core element of Continental's Electric Power Steering is the power-pack (ECU & motor). Only a slight adjustment to the respective vehicle class is needed. The ECU is combined with a motor whose power depends on the vehicle type. The power-pack is modular and scalable in its design and can therefore be deployed in cars from compact class to off-road vehicles. Three design concepts are available: radial, axial and concentric. Our column design with the EPS Power Pack is especially interesting for emerging markets. Since the system requires no hydraulic fluid, it is also more environmentally friendly and easy to service. The electric power steering also reduces fuel consumption and emissions since it only becomes active when it is actually needed.



*Electric Power Steering operates without any hydraulic components, reduces CO<sub>2</sub> emissions, and is thus ecologically friendly.*

## Emergency Steer Assist

In some dangerous situations, a targeted evasive maneuver offers a chance to prevent a crash even if the driver has no time left for emergency braking. The Emergency Steer Assist function assists the driver in these critical driving situations and helps to keep the vehicle stable. This is made possible by interaction between ESC, the electric steering, and driver assistance sensors. If the driver decides to take evasive action, Emergency Steer Assist calculates in milliseconds what line the optimum evasive maneuver could follow, termed the vehicle movement trajectory. To ensure that the vehicle remains stable, the evasive action is supported by a smooth steering movement.



## Active Rear Axle Kinematics

The Active Rear Axle Kinematics feature, which we are developing together with the Schaeffler Group, offers improved driving dynamics and enhanced driving safety. The change in rear axle kinematics produces more agile driving characteristics, and at higher speeds a harmonious vehicle reaction by varying the lane keeping at the rear axle. In the future function "Emergency Steer Assist," Active Rear Axle Kinematics supports an evasive maneuver in critical driving situations and helps the vehicle to remain stable. This is realized through the interaction between ESC and electric power steering (EPS), as well as sensors from the advanced driver assistance systems.



*Active Rear Axle Kinematics: more driving dynamics and a plus in driving safety.*

## Washer systems for the windshield and headlight cleaning nozzles

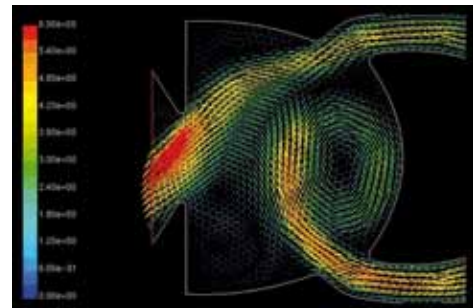
Soiled windshields or soiled headlights are a risk to any driver. Continental offers modular products and solutions with intelligent applications that increase the safety of drivers and that of those from oncoming traffic. The result is clean windshields and headlights, for an unrestricted view in any weather conditions and substantially reduced water consumption.



*Our windscreen and headlight cleaning systems are available as components or as complete systems.*

In addition, we offer automotive manufacturers solutions adapted to their needs, from compact, powerful pumps to robust hoses and heatable nozzles, as well as water reservoirs with filling level sensors.

Available as components or as complete systems, our washer systems are matched to the car manufacturers' requirements and installation prerequisites.



*Mushroom geometry for washer nozzles: optimal cleaning performance through the quick moistening of large areas, as well as a sharper limitation of the water jet and thus a lower water consumption.*

# Quality Without Compromise

The quality of our products, performance and processes has a decisive influence on the success of our company. Quality increases the value and shapes the image of our company with those people that are most associated to us.

## **Our customers**

We convince them with our performance and innovation. We supply them with flawless products and services to their highest satisfaction.

## **Our suppliers**

The reliability and quality of their performance is a prerequisite for successful cooperation.

## **Our employees**

We encourage their capabilities and personal development through recognizing their performance. Their commitment and competence secures our success.

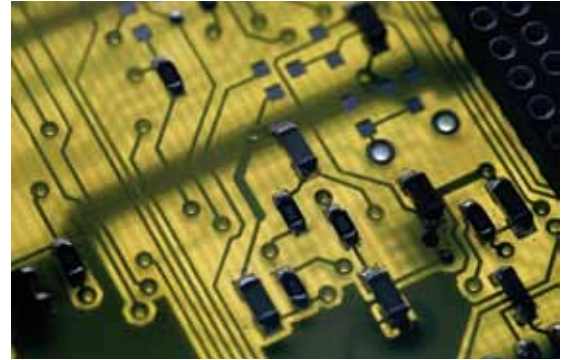
## **Our shareholders**

We strive for continuous business success and growth, thereby justifying their trust.

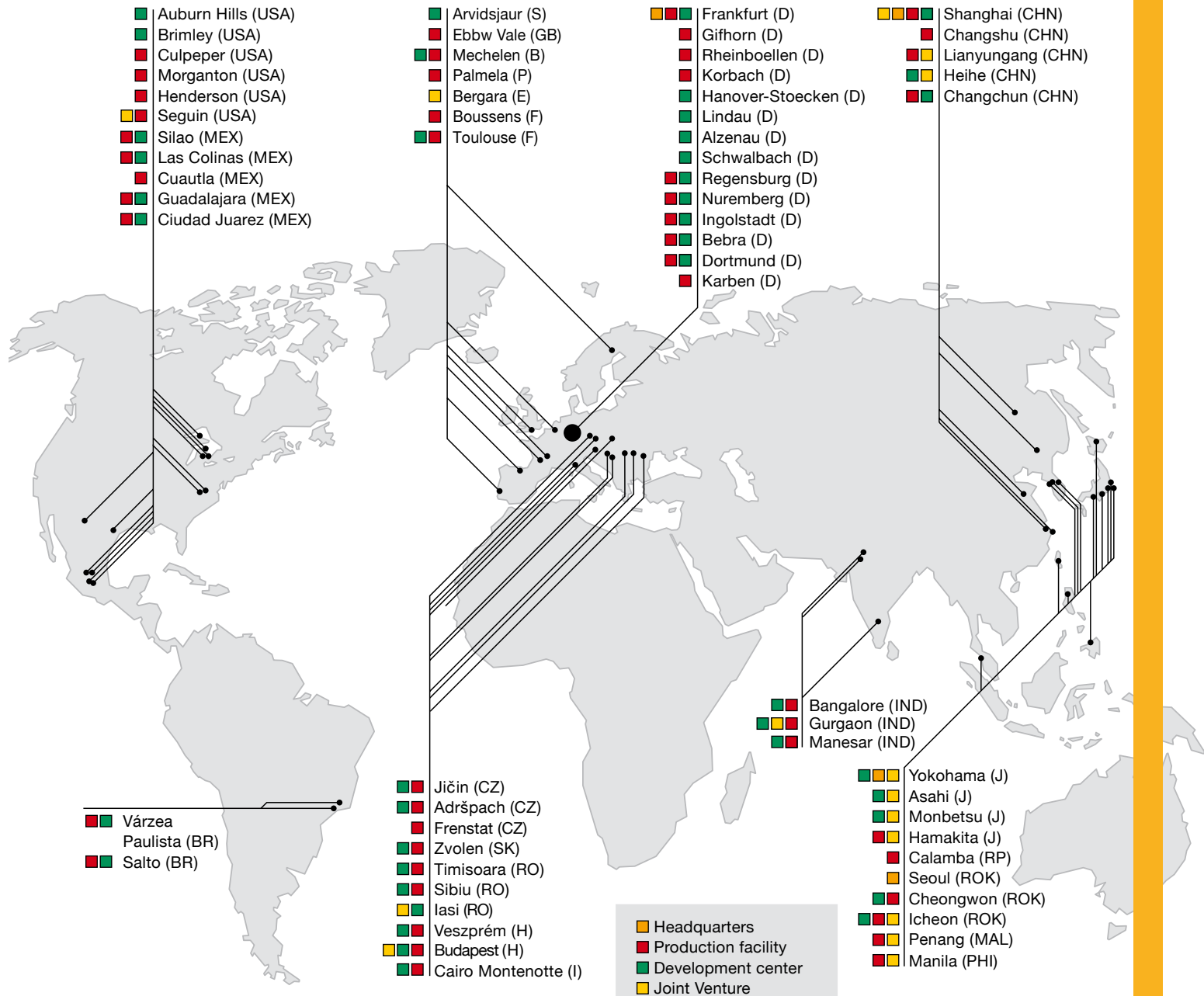
## **Our society**

We stand by our social responsibility. The long-term protection of people and the environment is an integral part of our activities.

**Our path to the continuous improvement of quality is the Q.BIC initiative.**



# Worldwide Locations



# Locations in Germany



Headquarters of the Chassis & Safety Division in Frankfurt a.M., Germany

**Continental Teves  
AG & Co. oHG**  
**Headquarters  
Chassis & Safety;  
Engineering center.**  
**Production of electronic  
brake systems.**  
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Guerickestrasse 7  
60488 Frankfurt a.M.  
Phone +49-69-7603-1  
Fax +49-69-761061

**Continental Teves  
AG & Co. oHG**  
**Production of brake  
calipers, brake cylinders,  
brake hoses, and  
air suspension systems**  
P.O. Box 1560  
38516 Gifhorn  
Alfred-Teves-Strasse 11  
38518 Gifhorn  
Phone +49-5371-83-0  
Fax +49-5371-3003

**Continental AG**  
**Development of  
air suspension systems**  
Jaedekamp 30  
30419 Hanover  
Phone +49-511-976-01  
Fax +49-511-938-81770

**Continental  
Automotive GmbH**  
**Passive Safety & ADAS  
Administration and  
engineering**  
Osterhofener Strasse 19  
93055 Regensburg  
Phone +49-941-790-0  
Fax +49-941-790-5457

**ContiTech Schlauch GmbH**  
**Production of brake hoses**  
Continentalstrasse 3-5  
34497 Korbach  
Phone +49-5631-581638  
Fax +49-5631-581273

**A.D.C. Automotive**  
**Distance Control  
Systems GmbH**  
**Development of driver  
assistance systems**  
Peter-Dornier-Straße 10  
88131 Lindau  
Phone +49-8382-9699-0  
Fax +49-8382-9699-19



Lindau, Germany

**Continental Teves  
AG & Co. oHG**  
**Production of  
brake calipers**  
P.O. Box 63  
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Teves Strasse  
55494 Rheinboellen  
Phone +49-6764-10-1  
Fax +49-6764-10-204

**Continental  
Safety Engineering  
International GmbH**  
**Product validation and  
integration**  
Carl-Zeiss-Strasse 9  
63755 Alzenau  
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Fax +49-6023-942-133

**Continental  
Automotive GmbH**  
**Administration and  
development of chassis  
components**  
Sodener Strasse 9  
65824 Schwalbach  
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Fax +49-6196-86571

**Continental  
Automotive GmbH**  
**Development of sensors**  
Arminiusstrasse 59  
44149 Dortmund  
Phone +49-231-1761-0  
Fax +49-231-1761-520

**Conti Temic  
microelectronic GmbH**  
**Development of electronic  
brake systems and  
production of airbag  
control units**  
Ringlerstrasse 17  
85057 Ingolstadt  
Phone +49-841-881-0  
Fax +49-841-881-2265

**Continental Temic GmbH**  
**Development of chassis  
components**  
Sieboldstrasse 19  
90411 Nuremberg  
Phone +49-911-9526-0  
Fax +49-911-9526-2529

# Locations in Europe

## Belgium

**Continental Automotive Benelux bvba**  
**Production of electronic brake systems and wheel speed sensors**  
 Generaal de Wittelaan 5  
 2800 Mechelen (B)  
 Phone +32-15-289511  
 Fax +32-15-289509

## Czech Republic

**Continental Teves Czech Republic, s.r.o.**  
**Development and production of boosters and brake cylinders**  
 Hradecka 1092  
 50601 Jičín (CZ)  
 Phone +420-493-589-111  
 Fax +420-493-589-210

**Continental Czech Republic, s.r.o.**  
**Development and Production Washer Systems**  
 Horni Adršpach 109  
 54942 Adršpach (CZ)  
 Phone +420-491-589-111  
 Fax +420-491-589-174

## France

**Continental Automotive France SAS**  
**Development of sensors and chassis components**  
 1, Av. Paul Ourliac, B.P. 83649  
 31036 Toulouse (F)  
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 Fax +33-561-192525

## Great Britain

**Continental Teves UK Ltd.**  
**Production of brake calipers and duo-servo brakes**  
 Waun-y-Pound  
 Industrial Estate  
 Ebbw Vale (Gwent) NP23 6PL  
 South Wales (GB)  
 Phone +44-1495-350350  
 Fax +44-1495-350351

## Hungary

**Continental Teves Hungary Kft.**  
**Development and production of wheel sensors, application of electronic brake systems, test track**  
 Házgyári út 6-8  
 8200 Veszprém (H)  
 Phone +36-88-540100  
 Fax +36-88-540109

**Budapest Temic Hungary kft.**  
**Production of sensors and electronic brake systems**  
 Napmátka u. 6  
 1106 Budapest (HU)  
 Phone +36-1-881-9500  
 Fax +36-1-881-9660

## Italy

**Continental Brakes Italy S.p.A.**  
**Development and production of drum brakes**  
 Corso Marconi, 160  
 17014 Cairo Montenotte  
 Savona (I)  
 Phone +39-019-5071-1  
 Fax +39-019-5071-242



*Zvolen, Slovakia*

## Portugal

**Continental Teves Portugal Sistemas de Travagem, LDA.**  
**Production of brake calipers**  
 Parque Industrial das Carrascas  
 Estrada Nacional 252 km 11  
 2950-402 Palmela (P)  
 Phone +351-21-238-7500  
 Fax +351-21-238-3830

## Romania

**Continental Automotiva Romania s.r.l.**  
**Development of electronic brake systems and chassis components**  
 Tehnopolis Park  
 B-dul Poitiers no. 10  
 70067 Iasi (RO)  
 Phone +40-232-307-002  
 Fax +40-232-220-331

**Continental Automotive Systems s.r.l.**  
**Development of electronic brake systems. Development and production of driver assistance systems.**  
 Salzburg Str. 8  
 550018 Sibiu (RO)  
 Phone +40-369-433-500  
 Fax +40-369-433-0

## Slovakia

**Continental Automotive Systems Slovakia s.r.o.**  
**Development and production of brake calipers**  
 Cesta ku Continentalu 8950/1  
 960 01 Zvolen (SK)  
 Phone +421-45-5318112  
 Fax +421-45-5318110

## Spain (Joint Venture)

**FIT Automoción, S.A.**  
**Production of brake calipers**  
 B° San Juan s/n, Aptdo. 80  
 20570 Bergara (Gipuzcoa) (E)  
 Phone +34-943-769044  
 Fax +34-943-769156

# Locations in the Americas

## Brazil

**Continental do Brasil  
Produtos Automotivos Ltda.**  
**Development and  
production of brake  
calipers, drum brakes,  
duo-servo brakes, brake  
cylinders, boosters,  
regulators and brake hoses**  
Av. Duque de Caxias 2422  
Jardim Santa Lucia  
13224-970 Várzea Paulista  
Sao Paulo (BR)  
Phone +55-11-4596-8000  
Fax +55-11-4596-8181

**Continental Brasil Indústria  
Automotiva Ltda.**  
**Development and  
production of sensors**  
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## Mexico

**Continental Automotive  
Mexicana S.A. de C.V.**  
**Development and  
production of sensors**  
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Oriente No 700  
Parque Industrial FIPASI  
Carretera Silao Irapuato  
Km. 5,3  
C.P. 36100 Silao Gto. (MEX)  
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Fax +52-472-791-0039

**Continental Automotive  
Mexicana S.A. de C.V.**  
**Las Colinas location  
Development and  
production of boosters  
and production of  
drum brakes**  
Paseo de las Colinas 219  
Parque Industrial y de  
Negocios, Las Colinas  
C.P. 36270 Silao Gto. (MEX)  
Phone +52-472-722-8100  
Fax +52-472-722-8191

**Continental Automotiva  
Guadalajara Mexico,  
S.A. de C.V.**  
**Development and production  
of speed sensors**  
Luis Bleriot 6720, Parque  
Industrial Panamericano  
Ciudad Juarez, Chihuahua,  
Mexico C.P. 32695  
Phone +52-656-629-8200  
Fax +52-656-633-0454

**Continental Automotiva  
Guadalajara Mexico,  
S.A. de C.V.**  
**Development and  
production of passive safety  
technologies**  
Camino a la Tijera No. 3  
Km. 3.5 Carr. Gdl-Mor. Tlajo-  
mulco de Zuñiga, Jalisco. C.P.  
45640 Guadalajara  
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*Auburn Hills, our NAFTA headquarters and engineering center*

## USA

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**Continental Automotive  
Systems US, Inc.**  
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**Continental Teves, Inc.**  
**Production of brake calipers**  
13456 Lovers Lane  
Culpeper, VA 22701 (USA)  
Phone +1-540-825-4100  
Fax +1-540-825-2366

**Continental Teves, Inc.**  
**Production of electronic  
brake systems**  
1103 Jamestown Road  
Morganton,  
NC 28655 (USA)  
Phone +1-828-584-4500  
Fax +1-828-584-5303

**Continental Teves, Inc.**  
**Plant Henderson  
Production of  
brake calipers**  
One Quality Way  
Fletcher, NC 28732 (USA)  
Phone +1-828-654-2000  
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# Locations in Asia



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Fax +86-21-6952-7280

**Shanghai Automotive Brake Systems Co., Ltd. (SABS) Headquarters and Shanghai plant; engineering and production of electronic brake systems, brake calipers, boosters and brake cylinders**  
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Jiading Industrial Zone  
201821 Shanghai (CHN)  
Phone +86-21-3916-3311  
Fax +86-21-3916-3333

**Continental Automotive Changchun Co., Ltd. Development and production of sensors and passive safety systems. Production of chassis components.**  
1981 Wuhan Avenue  
130033 Changchun (CHN)  
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Fax +86-431-8461-3761



Gurgaon, India

## India

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Industrial Zone  
201807 Shanghai (CHN)  
Phone +86-21-3916-5000  
Fax +86-21-5954-2573

**Continental Automotive Systems Changshu Co., Ltd. Production of hydraulic brake systems**  
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215500 Changshu,  
Jiangsu Province (CHN)  
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Fax +86-512-5235-8808

**Continental Automotive Corporation (Lianyungang) Co., Ltd. Production of sensors**  
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Fax +91-124-4366154

**Continental RICO Hydraulic Brakes India Private Ltd.**  
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Delhi-Jaipur Highway,  
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Haryana (IND)  
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# Locations in Asia



*Continental Engineering Center, Yokohama, Japan*

## Japan

**Continental Automotive Corporation (JV)  
Administration Yokohama**  
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Fax +81-45-444-3640

**Continental Automotive Corporation (JV)  
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Chiba 289-2505 (J)  
Phone +81-479-60-1550  
Fax +81-479-60-1803

**Continental Automotive Corporation (JV)  
Production of electronic brake systems**  
8000 Nakaze  
Hamakita-ku, Hamamatsu  
Shizuoka 434-0012 (J)  
Phone +81-53-588-3399  
Fax +81-53-588-5100

**Continental Automotive Corporation (JV)  
Monbetsu Test Center**  
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Fax +81-158-26-9037

**Continental Automotive Japan KK  
Headquarters**  
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**Continental Automotive Systems Corp.  
Development and production of passive safety, driver assistance systems and chassis components.**  
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**Continental Automotive Electronics Ltd.  
Development and production of sensors and chassis components**  
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Buyong-myeon  
Cheongwon-gun,  
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