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Bosch at the IAA 2013

Bosch Automotive Technology gains momentum: five percent more growth, around six percent return

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- ▶ Bosch Group's growth for this year expected to meet forecast of between two and four percent
- ▶ Bosch is pooling its strengths for automated driving by networking different areas of business
- ▶ Series production of 30 e-mobility projects to start by 2014

Stuttgart/Frankfurt am Main – In 2013, Bosch Automotive Technology's operative sales are expected to grow by some five percent, which means that the business sector will grow faster than global automobile production. Dr. Volkmar Denner, chairman of the board of management and head of research and development at Robert Bosch GmbH, spoke of the company's business development at the 65th International Motor Show (IAA) in Frankfurt am Main. This year, Bosch expects its Automotive Technology business sector to achieve a pre-tax return on sales of around six percent. The Bosch Group as a whole expects to register growth of two and four percent for 2013 as well, in line with forecasts. "We will also improve earnings as planned, even though considerable effort is still needed and our photovoltaics business is still taking a heavy toll," said Denner.

Growth in China and North America; gradual recovery in Europe

According to Bosch estimates, automobile production around the world will grow by an average of three percent annually in the years to come. This is still two percentage points lower than in the years leading up to the financial crisis. "North America and China will continue to drive the global automotive industry's growth, while Europe will gradually start to recover," said Denner. As an indicator of this recovery, Denner mentioned the

average age of passenger cars in Europe, which has reached a record high at almost nine years. In the medium term, this will mean that drivers will replace their used cars with new vehicles. In North America, Denner said, the current fleet of registered vehicles is around eleven years old. This is why demand for new cars is already on the rise in the region. "In a country like China, the catching-up process will take place on a much larger scale," said Denner. At the moment, vehicle density in China is about one-tenth of the western European figure.

For this reason, Bosch has intensified its activities in the emerging markets, and will have invested some 2.8 billion euros in the Asia Pacific region between 2011 and 2013. This shows that Bosch strategy is in line with industry trends: between 2005 and 2015, Japanese and German automotive companies will have increased their share of foreign production from about half to two-thirds. "As a globalized supplier, Bosch is keeping up with the international strategy of its customers," said Denner. Today, Bosch is already located close to automotive industry customers around the world with a global network of 95 manufacturing and 50 development locations. By the end of this year, the company will count 36,000 research and development associates around the world. Moreover, in Renningen, which is close to Stuttgart, Bosch is investing 300 million euros to build a new research center.

From the internal combustion engine to the fully electric drive

Bosch's intensive research activities have been decisive in securing the company's position as the market and innovative leader in the realm of electronic drive and safety systems. And when it comes to diesel and gasoline engines, there is still fuel savings potential: through further downsizing and improved combustion, fuel savings of an additional 20 percent can be achieved over 2012 levels. With this optimized technology, even the strict CO₂ emissions standards that are expected in Europe from 2020 can be met. Depending on the vehicle class, this objective can be achieved with varying levels of electrification. Here, Bosch offers an extensive portfolio of products. For instance, the boost recuperation system is an affordable entry-level hybrid with a 48-volt generator and a compact lithium-ion battery. The strong and plug-in hybrids complete the Bosch portfolio. By 2014, the company will have contributed to 30 series production projects related to e-mobility: from a fully electric system for compact cars to an electrified sports car.

"Bosch is pooling its strengths for automated driving"

Ever stricter environmental protection and accident prevention standards are being introduced around the world. This will stimulate growth in the realms of powertrain electrification and automated driving. In the area of driver assistance, market volumes are expected to grow by a third each year between 2013 and 2017. Today, Bosch generates annual sales of five billion euros with driver assistance and safety systems. In total, 5,000 Bosch engineers are working in these areas.

Video link
[Automated
driving](#)



In addition to improving driver assistance systems and sensor technology, vehicle networking is one of the main technological challenges on the road to automated driving. In the future, large amounts of data will be transported via mobile communication interfaces. They will also be recorded and analyzed for the cloud and connected to other data sources. As a result, vehicles will be increasingly connected to their environment, and their systems will be able to recognize and respond to hazards more quickly. For instance, if a traffic jam starts in a bend in the road and a driver hits the brakes, the vehicle will recognize the danger and warn other road users who are headed toward the same spot.

In the area of vehicle networking, Bosch is working closely with external partners and has engaged in pre-competitive cooperation in efforts to further develop technologies that will enable fully automated driving. For instance, Bosch is a founding member of the Center for Automotive Research (CARs), an interdisciplinary research program at Stanford University.

Above all, Bosch takes advantage of the benefits of being a global company with more than 300,000 associates. Its various divisions cooperate with one another across different business areas. This cooperation is necessary when it comes to innovations such as human detection technology, which has applications in both pedestrian protection systems for automobiles and in surveillance-based security systems for buildings. Here, several Bosch divisions are working together and using a common software platform. "Bosch is pooling its strengths for automated driving. We cultivate internal alliances through informal channels," said Denner.

Bosch Software Innovations, a subsidiary that focuses on the development of software systems, offers solutions that are helping to make the internet of things and services a reality. This, in turn, is paving the way for vehicle networking. The company's applications are in use across Bosch's business sectors. Cars on the streets will be just as much a part of the internet of things and services as refrigerators in people's homes and packaging machines on factory floors.

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Automotive Technology is the largest Bosch Group business sector. In 2012, its sales came to 31.1 billion euros, or 59 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. Its roughly 177,000 Automotive Technology associates worldwide mainly work in the following areas of business: injection technology for internal-combustion engines, alternative powertrain concepts, efficient and networked powertrain peripherals, systems for active and passive driving safety, assistance and comfort functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, and concepts, technology, and service for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP® anti-skid system, and common-rail diesel technology.

The Bosch Group is a leading global supplier of technology and services. In fiscal 2012, its roughly 306,000 associates generated sales of 52.5 billion euros. Since the beginning of 2013, its operations have been divided into four business sectors: Automotive Technology, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 360 subsidiaries and regional companies in some 50 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. Bosch spent some 4.8 billion euros for research and development in 2012, and applied for nearly 4,800 patents worldwide. The Bosch Group's products and services are designed to fascinate, and to improve the quality of life by providing solutions which are both innovative and beneficial. In this way, the company offers technology worldwide that is "Invented for life."

Additional information can be accessed at www.bosch.com, www.bosch-press.com and <http://twitter.com/BoschPresse>

**The future of driving:
electric, automated, connected**

Presentation by Dr. Volkmar Denner,
Chairman of the Bosch Board of Management
at the press conference for the IAA
in Frankfurt am Main, September 10, 2013

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Ladies and gentlemen,

The IAA gives automakers and suppliers like Bosch the opportunity to put an avalanche of innovation on display. At the same time, events like this one give rise to at least two fundamental questions for the automotive industry.

- First, how will cars drive in the future? In all likelihood, they will be electric, automated, and connected. Bosch offers technological responses to this question – multifaceted responses that complement each other, and innovative responses that open up new markets, or at least increase market shares.
- Second, where is the automotive industry heading? How Asian will it become, and how European and American will it remain? Here, Bosch offers economic responses – responses that are proactive, diversified, and socially responsible. Being more present in emerging markets doesn't necessarily mean having less of a presence in established markets. Taking advantage of dynamic growth in countries such as China is only half the story. Stimulating the recent weak growth in Europe with high-tech solutions is the other half. While this task requires tremendous creativity, it is the only way we can safeguard the long-term success of our European locations.

Whether we're talking about the further development of automotive technology or of the entire automotive industry – Bosch's path is one of innovation.

Bosch growth: automotive technology is gaining momentum

First of all, let's have a look at our business. According to our estimates, the Bosch Group will register growth of 2 to 4 percent this year. We are improving our earnings step by step, even though considerable effort is still needed, and our photovoltaics business is still taking a very heavy toll. After a modest start to the year, our Automotive Technology business sector has been gaining significant momentum. Its operative sales will likely grow by 5 percent in 2013 – faster than global automobile production. And it is precisely in automotive technology that earnings will improve. This year, we are expecting a pre-tax return on sales of around 6 percent.

Long-term trends: an advantage for globalized suppliers

But what are the prospects beyond this year? The long-term trends in the automotive market affect suppliers like Bosch as well. In this regard, I would like to focus on a few important points.

- According to our estimates, global automobile production will grow by an average of 3 percent in the coming years. This is one to two percentage points lower than in the years before the financial crisis, the effects of which are still being felt in Europe in particular. Even so, weakness here will be offset by growth in North America and above all China.
- The European automotive market will at least begin to experience a gradual revival. One of the reasons for this is the average age of passenger cars, which has reached a record high of nearly nine years. In North America, however, the average age is eleven years –and growing demand there can be seen as the resulting catching-up process. A country

like China, on the other hand, is catching up on a much larger scale. Vehicle density in China has just recently reached a tenth of western Europe's, and the country's dynamic growth will continue against this backdrop.

- Manufacturing will also increase in the emerging markets. For example, German and Japanese companies are increasing their share of foreign manufacturing activities at roughly the same pace – from around half in 2005 to two-thirds by 2015. Globalized suppliers clearly have an advantage here.
- Around the globe, environmental protection as well as accident prevention targets and standards are becoming ever stricter. This is giving a boost to powertrain electrification and the automation of driving, both of which are coming step by step. By 2020, we expect that 12 million newly registered vehicles will have an electrified powertrain. After that, the number will see a steeper increase. Furthermore, by 2025, nearly every new car sold worldwide will be connected with mobile data networks – and the data transfer rate will be so high that real-time hazard warnings will also be possible via car-to-x communication. This is an important prerequisite for automated driving.

Bosch's strengths: where development is dynamic

As this short overview has shown, the automotive industry is facing a number of economic and technical challenges. Bosch already has the expertise required to tackle these challenges.

- We are already close to our customers in the automotive industry, wherever they are in the world – with a network comprising 95 manufacturing locations as well as

50 research and development sites. Of the 36,000 engineers working at Bosch in the area of automotive technology, by the end of this year 19,000 will be located in Europe, 2,000 will be located in the Americas, and nearly 15,000 will be located in Asia Pacific.

- Our strong technical presence is paying off: in the last decade, we already registered above-average growth in Asia's emerging markets. For example, China's and India's share of global vehicle production has tripled since 2003, and Bosch's sales in these countries have increased sevenfold.
- And it is especially in powertrain and safety systems, the most technically dynamic areas of development, that we are market leaders and have an innovative edge. Bosch is number one in the areas of fuel injection and brake control systems, as well as in the realm of sensor technology. This is bolstered by cutting-edge production processes that are highly precise, and above all, unique. For example, we use ultrashort pulse lasers to drill fine nozzle holes for our gasoline direct injection systems. And our business continues to develop positively – also when it comes to components for CNG powertrains, for which we produce the world's smallest injector. In 2012, we produced a million units – the number will likely surpass 1.3 million in 2013. Driver assistance systems are experiencing particularly strong growth. Market volume in this area will increase by a third each year between 2013 and 2017 – Bosch's growth will be even higher than this, and considerably so.

What will count in the future: the global innovation network

To secure its future, Bosch is focusing on the success factors that are decisive in the automotive industry: quality, internationality, and innovative strength.

- We are continuing to expand our extensive global development and manufacturing network, for instance with new locations in eastern Europe and Asia. In the Asia-Pacific region alone, we will have invested some 2.8 billion euros between 2011 and 2013. China is our main focus in the region. With a total investment of 300 million euros, we opened three new automotive technology locations in the country in 2013 alone, namely in Nanjing, Donghai, and Chengdu. What is more, our "local for local" development strategy has played a particularly important role in China. For instance, together with German and local manufacturers, we have developed navigation systems that are specially designed for the Chinese market.
- Beyond our low-cost solutions for emerging markets, we are focusing on maintaining our leading position when it comes to technological progress. This is essential if we are to secure the lasting success of our locations in established markets. To this end, we have invested some 300 million euros to build a new research center in Renningen, close to Stuttgart. With our electronics and sensor technology expertise, we will help shape the future of the automobile in the areas of electric, automated, and connected driving.

Electric driving: developing innovative business models

The technological progress we have made with gasoline and diesel engines is also significant on our path to e-mobility. We can now achieve fuel savings with internal combustion engines of some 20 percent even over 2012 levels. And we are still leveraging additional potential to make driving more fuel-efficient. For instance, we have expanded the start-stop system to make it a coasting assistant. To this end, a sensor gives drivers advance warning of upcoming bends in the road or town limits. On highways, this systems networking translates to a real fuel savings of up to 15 percent in real driving conditions. That leads to not just lower fuel costs, but also lower CO₂ emissions. This is where e-mobility comes full circle: thanks to our efficiency technology, the strict CO₂ emissions standards expected to come into force in the European Union in 2020 can be met with varying levels of electrification, depending on the vehicle class. Our product portfolio for the hybrid drive will also help achieve this objective. We have already made hybrid drive systems possible in the mid-sized vehicle segment, for instance with the boost recuperation system. With its 48-volt generator and compact lithium-ion battery, the system allows us to recuperate so much braking energy that we can achieve a fuel savings of seven percent – a huge benefit at a low cost.

We are also realizing major solutions with the hydraulic, strong, and plug-in hybrids, and with the purely electric drive like the one we provided for the series-produced Fiat 500e. By 2014, Bosch will have worked on about 30 orders related to powertrain electrification. While these projects are not immediately intended for the mass market, they are paving the way for it, also in emotional terms. They represent a new kind of

driving experience, one that is quiet and enables rapid acceleration, particularly at low rpms. The Porsche Panamera with Bosch plug-in hybrid technology, which is on display at this year's IAA, is one example of this. Such vehicles provide a new user experience and can promote the market's further development.

Despite the progress we have made, we still have quite a bit of work to do, both in business and technological terms. Our aim is to reduce the cost of lithium-ion batteries by at least half, and to at least double their energy density. To this end, we have agreed to enter into a joint venture with two Japanese partners, GS Yuasa and Mitsubishi, subject to the approval of the antitrust authorities. The potential partnership is set to be headquartered in Stuttgart, and will allow us to combine our expertise in electronics and sensor technology with our partners' in-depth knowledge of cell chemistry. Moreover, it will enhance Bosch's access to the Japanese market.

For Bosch, e-mobility is far more than just the drive system of the future for cars. With systems for e-bikes and e-scooters, we have made it possible to experience e-mobility in other ways as well. In so doing, we are supporting the multi-modal transport concepts of major cities. And we are also involved in providing a consistent infrastructure. For example, our subsidiary Bosch Software Innovations has enabled e-roaming, which allows customers to use the charge spots of different providers. The company has developed the required software platform for Hubeat GmbH, a consortium of automotive and energy companies in Berlin. Bosch Software Innovations also offers the corresponding "starter package" for charge spot operators.

Particularly in the area of e-mobility, Bosch has focused on developing innovative business models, and this goes well beyond the traditional product business.

Saving energy and lives: the Bosch iBooster

And yet many new Bosch products from a broad range of areas are compatible with this new type of driving. Among them are electronically controlled brake boosters such as the iBooster, which can operate without any vacuum from the internal combustion engine and remains active during electric driving as a result. Depending on vehicle design, the iBooster can increase the range of electric driving by up to 20 percent. What is more, it builds up braking pressure three times faster than conventional pumps. At speeds of 30 kilometers per hour, this can shorten braking distances by up to 1.5 meters. Combined with ESP®, our automatic emergency braking can prevent a third of all head-on collisions with pedestrians. With the iBooster, up to half of these accidents can be prevented. This is technology that saves lives – in other words, technology that is "Invented for life".

Automated driving: new sensors, new systems

Innovations such as these clearly demonstrate that we aim to achieve safe and sustainable mobility. And the road to accident-free driving requires more automation, as more than 90 percent of all traffic accidents are the result of human error. This fact alone is reason enough to reduce the burden on drivers. In this area, Bosch has developed more pioneering solutions than any other supplier – take ABS and ESP®, to name only two. Today, we are the only automotive supplier that is testing automated driving on Germany's roads. At Bosch, more than 5,000

engineers are working on the future of our safety and driver assistance systems. We have made progress not only in the realm of sensor technology, for instance with the stereo video camera that we are bringing to the car next year. We are also developing a range of new assistance systems. These systems demonstrate the three traffic situations in which we can begin to automate driving:

- Parking is the first. In 2015, Bosch will be launching an expanded parking assistant. The system will include a remote control that helps maneuver the car in crowded garages. In the future, the car will be able to look for a space in parking structures on its own with the help of a 360-degree video sensor.
- The second is stop and go. As early as 2014, Bosch will be launching a traffic jam assistant that keeps the vehicle in its lane in congested traffic by way of steering intervention. In the future, the system will become a traffic jam pilot with an automated lane-change function.
- Third, the future of automated driving on the freeway has taken a clear direction. This field of development includes combining adaptive cruise control with the lane-keeping assistance function. By the end of this decade, a highway pilot will be available.

To achieve the vision of fully automated driving, which means that drivers will no longer need to operate the steering wheel even off the highway, a great deal more is needed. In our view, full automation is possible only with connected driving. The more ambitious the safety functions of the future are, the greater the need for car-to-car communication. For it to work, at least 50 percent of the vehicles in flowing traffic have to be

sharing data with each other in real time. Based on the market trends outlined today, we expect this to become a realistic possibility within the next decade.

Connected driving: more safety, more service

The aim of vehicle networking is not only accident-free driving. It also strives to make driving more comfortable and to increase the range of services on offer. Here, too, Bosch has developed a broad range of solutions:

- The first is the “connectivity control unit”. In connection with vehicle condition monitoring, a CCU paves the way for new Bosch services for fleet operators, such as timely error analysis and targeted maintenance. A major leasing company will be the first to use this in 2014.
- The second is Drivelog, an online portal. The platform provides drivers with a digital overview of all vehicle-related costs and service offers. Our portal already counts almost 250,000 visitors each month. And this number could increase very soon: as of now, all members of the German motor club ADAC can use selected Drivelog functions.
- The third is mySPIN. This new Bosch solution aims to integrate smart phones into the vehicle. In other words, with this technology we are safely bringing the internet into the car. Via mySPIN, smart phone apps appear on the dashboard display.

Solutions such as this one help keep the car young and attractive to buyers for whom a mobile internet connection is particularly important. At the same time, mySPIN represents Bosch's universal approach: the more features make their way

into the car, the easier operating them should be. Bosch is also market leader in the area of freely programmable instrument clusters. We have developed a driver information system for General Motors that can be controlled by natural voice input – drivers can speak as freely as they would with other passengers in the car. Cadillac was the first to equip its vehicles with the system, and Opel has followed suit with a variant in the new Insignia, which is being unveiled at the IAA.

The future of driving: converging development paths

This brings me to my conclusion. Whatever our engineers are working on – whether they are making driving more comfortable, safer, or more economical – their efforts are improving quality of life. This is where the main lines of automotive development converge: electrification, automation, and connectivity are interconnected. Bosch is moving forward briskly on all three of these paths – and this will give rise to new growth opportunities, especially in Europe.

Bosch compact

September 2013

Bosch automotive technology at the IAA 2013

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From products such as the iBooster to advances in electromobility and highly-automated vehicles

Technical highlights: eClutch, iBooster, stereo video camera

eClutch: In the future, the Bosch eClutch will allow drivers using a manual transmission to use first gear without engaging the clutch in stop-and-go traffic. The electronically controlled clutch actuation system closes the gap between automatic and manual shifting systems. Moreover, the eClutch enables coasting, which lowers fuel consumption. Independently of the driver, the clutch decouples the engine from the transmission if the driver is no longer accelerating. The engine then stops. The result is an average real fuel savings of 10 percent.

iBooster: The electronically controlled brake booster can operate without any vacuum from the internal combustion engine and remains active during electric driving. Depending on vehicle design, the iBooster can increase the range of electric vehicles by up to 20 percent. Moreover, it builds up braking pressure three times faster than conventional pumps. At speeds of 30 kilometers per hour, this can shorten braking distances by up to 1.5 meters. With ESP®, automatic emergency braking can prevent a third of all frontal collisions with pedestrians. With iBooster, up to half of these collisions can be prevented.

Electronic horizon: Bosch is enhancing the start-stop system to make it a coasting assistant. To this end, the navigation function is used as a sensor that warns drivers of upcoming bends in the road and town limits. On highways, this systems networking will lead to fuel savings of up to 15 percent in real driving conditions. Not only will this result in lower fuel costs, it will also reduce CO₂ emissions.

Boost recuperation system: This is Bosch's entry-level hybrid system for the mid-size segment. The generator is the system's core element. Thanks to its higher voltage, it provides the basis for the new 48-volt vehicle electrical systems. The system has several benefits: first, it reduces fuel consumption during coasting. Second, thanks to its higher performance, the system makes far better use of regenerative braking than conventional generators. This results in fuel savings of up to 7 percent.

CUE entertainment system: Bosch has developed a driver information system for General Motors that can be controlled by natural voice input – drivers can speak as freely as they would with other passengers in the car. Cadillac was the first to equip its vehicles with the system.

TFT displays: Bosch is the market leader in the area of freely programmable instrument clusters. For premium vehicle models, Bosch has developed the TFT display, which is based on state of the art display technology. Here, Bosch offers a modular building block system, which means that TFT can be adapted to a wide range of requirements.

Stereo video camera: In 2014, Bosch will be starting series production of a stereo video camera. One single sensor will be able to trigger automatic emergency braking for pedestrian safety – for instance when playing children suddenly run into the street.

Products and strategies on the road to purely electric driving

The internal combustion engine: On the road to purely electric driving, the further technical development of gasoline and diesel engines will remain significant. Here, there is fuel savings potential of an additional 20 percent, even over 2012. Thanks to efficiency technology, the strict CO₂ emissions standards expected to come into force in the EU in 2020 can be met with varying levels of electrification, depending on the vehicle class.

Hybrid drive system: In the realm of powertrain electrification, Bosch has developed a broad range of technologies. For instance, Bosch has adapted its boost recuperation system for mid-sized vehicles. The system features a 48-volt generator and a compact lithium-ion battery. In addition to this, Bosch has gone one step further with hydraulic, strong, and plug-in hybrids. The Porsche Panamera with Bosch plug-in hybrid technology will be presented at the IAA 2013. Such vehicles spark the enthusiasm of car buyers and can promote the market's further development.

The electric drive: With the Fiat 500e, Chrysler has used Bosch components in the series production of a purely electric vehicle. By the end of 2014, the company will already be working on 30 orders related to powertrain electrification. While these projects are not immediately intended for the mass market, they are paving the way for it, also in emotional terms. They represent a new kind of driving experience, one that is quiet and enables rapid acceleration, particularly at low rpms.

Market developments: “Electromobility is currently still a niche business, but after 2020 it could very well become a mass market. I expect that by 2020, electric cars will have a range of at least 300 kilometers.”

(Dr. Volkmar Denner, chairman of the board of management of Robert Bosch GmbH)

Battery development: Bosch aims to cut the cost of lithium-ion batteries by at least half, and to at least double their energy intensity. These are two of the main reasons why Bosch has entered into a joint venture with two Japanese partners, GS Yuasa and Mitsubishi. Subject to the approval of antitrust authorities, the potential partners aim to combine their electronics and sensor technology expertise with their cell chemistry know-how.

Business models: E-mobility goes far beyond the traditional product business. With components for e-bikes and e-scooters, Bosch supports multi-modal transport concepts in urban centers. Its subsidiary Bosch Software Innovations is developing an infrastructure for such initiatives. For example, the system enables e-roaming, which allows vehicles to use the charge spots of different providers. The company has developed such a software platform for Berliner Hubeject GmbH, a consortium of automotive and energy companies. In addition, Bosch Software Innovations offers the corresponding starter package for charge spot operators.

Driver assistance: on the path to fully-automated driving

Market opportunities: In the coming years, the market for driver assistance systems is expected to grow by more than 20 percent per year. At Bosch, more than 5,000 engineers worldwide are working in the area of safety and driver assistance systems. In 2012, the automotive supplier generated more than five billion euros in sales with such systems. In order to achieve the highest possible rating of five stars, Euro NCAP stipulates that vehicles

will require driver assistance features in the future. From 2014 onward, at least one assistance function will be mandatory. And starting in 2016, vehicles will require a predictive pedestrian protection feature. This will give rise to new growth opportunities.

Motivation: Making accident-free driving reality will include achieving the goal of automated driving. Today, more than 90 percent of traffic accidents are the result of human error, and accidents around the world cause 1.3 million deaths each year. Reducing the number of accidents is a major focus of Bosch research. For instance, if all vehicles were equipped with an automatic emergency braking system, up to 72 percent of rear-end collisions resulting in injury could be prevented.

Product portfolio: Bosch either currently offers the following functions, or plans to do so in the near future: driver drowsiness detection, predictive emergency braking, a lane-keeping assistance function, an approaching vehicle warning, a construction site assistant, and predictive pedestrian protection.

Traffic jam assistant: Today, drivers must be able to concentrate when at the wheel in traffic jams. In 2014, Bosch will launch a traffic jam assistant that keeps the vehicle in its lane in congested traffic by way of steering intervention. In the future, the system will become a traffic jam pilot with an automated lane-change function.

Parking assistant: Long searches for parking spots and difficult parking maneuvers will soon be a thing of the past. In 2015, Bosch will be launching an expanded parking assistant. The system will include a remote control that helps maneuver the car in crowded garages. In the future, the car will be able to look for a space in parking structures on its own with the help of a 360-degree video sensor.

Highly-automated driving: The future of automated driving on the freeway has taken a clear direction. This field of development includes combining adaptive cruise control with the lane-keeping assistance function. By the end of this decade, a highway pilot will be available. The more ambitious the safety functions of the future will be, the greater the need for car-to-car communication and data transfer in real time.

Connected driving: safer and more convenient

Connectivity Control Unit (CCU): In connection with vehicle condition monitoring, a CCU paves the way for new Bosch services for fleet operators, such as timely error analysis and targeted maintenance. A major leasing company will be the first to use CCU in 2014.

Drivelog: This platform provides drivers with a digital overview of all vehicle-related costs and service offers. The online portal already counts almost 250,000 visitors each month. And this number could increase very soon: starting now, all members of the German motor club ADAC can use selected Drivelog functions.

mySPIN: This new Bosch solution aims to integrate smartphones into the vehicle. In other words, this technology safely brings the internet into the car. Via mySPIN, smartphone apps appear on the central console's display.

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Bosch Compact **Gasoline injection systems**

September 2013
PI 8259 GS FF/Moe

How the market for direct injection is developing,
and why port fuel injection still has a future

Port fuel injection systems: cost effective, with potential for the future

Market situation: In 2012, roughly 60 percent of all newly manufactured vehicles featured gasoline port-fuel injection. Bosch is the world's largest manufacturer of injectors, supplying some 70 automakers worldwide with its systems.

How it works: In gasoline port-fuel injection, the air-fuel mix is created outside the combustion chamber, in the injection manifold. The injector injects the fuel upstream of the intake valve. During the intake phase, the air-fuel mix is drawn in through the open intake valve into the combustion chamber. The injection valves are selected in such a way that the engine's fuel requirements are covered at all times – also under full load and at high speeds. However, even when idling, small volumes of fuel can be precisely metered and injected.

All-rounder: A special variant of the Bosch EV14 injection valve also features in the latest Bugatti Veyron model. This example shows that port fuel injection is also suitable for extremely powerful vehicles, and even for super sports cars. The Bosch EV14 injection valve's nine variants mean that it can be used in a variety of applications. Some of them also feature in price-sensitive vehicle segments and markets, and even in personal water craft.

Future markets: In markets such as Brazil, China, and the Asean countries, port-fuel injection is still on the rise, as vehicle numbers show. Bosch is already positioning itself in this market, and will start manufacturing injection valves in Jakarta in 2014, for example.

Mature technology: Bosch can look back on 45 years of experience in manufacturing port fuel injectors. Bosch supplied its first valve in 1967, when most vehicles were still equipped with carburetors. Since then, the supplier has manufactured more than 1.3 billion injectors.

Alternative powertrains: Even in electrical powertrains, port fuel injection will still play a role. This is because it is less expensive than direct injection, and any efficiency deficits will be offset by the electrical components. Port fuel injection is also the basis for alternative-fuel powertrains such as the Bosch CNG systems or flex fuel – in other words, the components of the ethanol powertrains that are mainly sold in South America.

Advanced port fuel injection: economical systems approach

Advanced port fuel injection: Bosch has developed four individual approaches to improving gasoline port-fuel injection. This cost-effective systems approach can reduce fuel consumption by as much as 12 percent. In addition, advanced port fuel injection (advanced PFI) can improve torque and engine performance. Using this system, therefore, drivers can reduce fuel costs while experiencing greater driving enjoyment at the same time.

1. Scavenging: In this approach, a higher exhaust-gas velocity at low engine speed brings forward the operating point of the exhaust-gas turbocharger. This means the turbocharger can respond earlier, as there is a sufficient flow of exhaust gas. In this way, the often-cited turbo lag can be avoided. This is because scavenging improves the intake of fresh air, and a greater volume of hotter exhaust gas is delivered to the turbocharger's turbine. When combined with downsizing and turbocharging, scavenging can bring about a fuel saving of some 10 percent.

2. Open valve injection: In this approach, the fuel is injected into the fresh air streaming into the intake manifold during the induction cycle. As a result, the fuel is vaporized in the combustion chamber, reducing the temperature there. Open valve injection thus makes a higher rate of compression possible. Fuel consumption can be reduced by 2 percent in this way.

Video link
[Scavenging](#)



3. Fuel pressure: When starting the engine, fuel pressure is increased to allow a more homogeneous mix to be created. During a cold start, for example, system pressure increases to 6 bar. This improves atomization, and means that less fuel is deposited on the wall of the intake manifold. In this way, the Bosch advanced PFI system reduces hydrocarbon emissions by roughly 20 percent.

4. Twin injection: In this final approach, each intake duct is fitted with two injection valves. Twin injection means that the fuel is atomized even more finely. This allows the air-fuel mix to be injected far more efficiently and flexibly. Twin injection also helps to reduce the amount of fluid deposited as a film on the intake manifold walls. Moreover, scavenging is only possible in port fuel injection if there is twin injection.

Gasoline direct injection: powerful and growing in popularity

Growth market: In 2002, just 2 percent of vehicles featured gasoline direct injection systems. One decade later, this figure was 22 percent. In 2012, Bosch supplied more than 5 million gasoline direct injection systems. By 2015, this figure will be more than 9 million. In this segment, Bosch is growing by 50 percent annually, and currently generates sales of 1.3 billion euros. This business will continue to grow in the future. Especially in the U.S., this technology is very much in demand.

How it works: Engines with gasoline direct injection prepare the air-fuel mix directly in the combustion chamber. All that flows through the open intake valve in the intake duct is fresh air. High-pressure injection valves inject the fuel directly into the combustion chamber. This cools the combustion chamber, making basic compression higher and reducing propensity to knock. The economical consumption and low emissions of gasoline direct injection are due to the precise metering, preparation, and distribution of air and fuel for each individual combustion cycle.

Efficiency: Gasoline direct injection is one of the key components for fulfilling future emissions standards. Modern injectors play an essential part in optimizing the inner workings of engines, and thus in reducing pollutant emissions. In the future, increasing pressure to more than 200 bar could bring further advances. The Bosch HDEV5 injector already works at a pressure of roughly 200 bar.

Video link
[Gasoline direct injection](#)



Customer benefit: In combination with downsizing and turbocharging, gasoline direct injection reduces consumption, and thus CO₂ emissions, by as much as 15 percent. In combination with downsizing, turbocharging, and scavenging, gasoline direct injection provides an impressive improvement in response, as well as improved driving performance. This is because torque is increased by as much as 50 percent.

Pioneering achievements: Bosch is regarded as the pioneer of gasoline direct injection. Bosch launched this technology in 1951, initially for the two-stroke engine of the compact Gutbrod Superior car. Three years later, gasoline direct injection debuted in the four-stroke engine of the legendary “gullwing” Mercedes-Benz 300 SL.

Production: In 2011, the 25 millionth injection valve and 5 millionth high-pressure pump rolled off the production lines in the Bosch global manufacturing network. And in 2012, Bosch celebrated two further production milestones: 50 million injectors and 10 million high-pressure pumps.

Press photos: 1-GS-19437, 1-GS-19438, 1-GS-19439

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Bosch Compact **Diesel injection systems**

Pressure increase to 2 500 bar, modular solenoid valves, and piezo technology

September 2013
PI 8260 DS FF/Moe

Common-rail injection: very fast and very clean

Common-rail diesel: In 2012, at least four of every five diesel vehicles sold worldwide were equipped with a common-rail system. Bosch is the market leader for this technology: in 2012, more than 8 million systems were delivered, and in 2015 this number will reach 12 million – a 50 percent increase.

Video animation
[Common-rail system](#)



Piezo injectors – high-pressure pioneers: The CRS3-25 common-rail system features the first piezo injector from Bosch for passenger cars to operate at 2 500 bar. With their increased injection pressure, these new Bosch piezo models are on the technological cutting edge. By optimizing injection, fuel is more finely atomized and can be better burned. Moreover, advanced piezo injectors enable multiple injection comprising up to ten cycles. This is important, as it will make complying with future emissions limits and further increasing engine performance possible.

Solenoid valve injectors: Along with piezo systems, solenoid valve injectors are also continuously being optimized. One example of this is the new Bosch CRI2-20, which provides an injection pressure of 2 000 bar. All Bosch solenoid valve injectors have been designed according to a modular principle, which allows automakers to use different model generations in the same basic engine.

Continuous improvement: A further increase in pressure is also possible for solenoid valve injectors. Pressure-balanced valves make this possible, as a high-pressure accumulator integrated into the injector prevents pressure fluctuations in the system. Fuel can be more efficiently injected this way, resulting in lower emissions and a quieter system. Just like piezo injectors,

solenoid valve injectors make multiple injection possible. This helps to reduce fuel consumption, thereby cutting the levels of CO₂, pollutants, and noise emitted by the engine.

Background information: piezo injectors and emissions standards

How piezo injectors work: The piezoelectric effect enables the transformation of mechanical load into an electrical signal and vice versa. When an electrical current is applied to piezoelectric ceramic, its length instantly changes shape. This change in length can be used to generate mechanical force. A piezo injector uses this effect to activate an injection valve's opening and closing mechanism. In 2005, Bosch and Siemens VDO were jointly awarded the German Future Prize for bringing piezo technology into series production.

Milestones: Series production of common-rail systems in passenger cars began in 1997. The system was first installed in the Mercedes-Benz C 220 CDI and the Alfa Romeo 156 JTD. At that time, it delivered injection pressure of up to 1 350 bar. Beyond that, diesel technology has also celebrated considerable success in motor racing. Since 2006, diesels have won every 24-hour race at Le Mans. All the winning cars have had specially-developed Bosch racing technology on board.

Emissions legislation: Bosch injection systems play an important role in ensuring that diesel vehicles worldwide are able to comply with current and future emissions standards. By further increasing pressure and improving injection, automakers will be able to perfectly synchronize engine operation with exhaust-gas treatment.

Fuel quality: One challenge for injection systems is the inconsistent quality of fuel worldwide. For example, the lubricant properties of diesel often vary considerably between regions. With this in mind, Bosch has developed its common-rail injectors to be fundamentally suitable for worldwide use.

Press photos: 1-DS-19440, 1-DS-19441

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Bosch Compact **Alternative fuels** From CNG powertrains to the Flexstart system for ethanol

September 2013
PI 8261 GS FF/Moe

Natural gas: cost-effective alternative for reducing CO₂ emissions

Market: Over the past 10 years, the market has seen annual growth of 25 percent. Bosch compressed natural gas (CNG) technology can be found in series-produced passenger cars made by the Volkswagen Group, GM, Tata, Fiat, and Opel.

Technology: In cars fitted with Bosch CNG systems, driving behavior is the same regardless of whether the car is running on CNG or gasoline. The system can also start in CNG mode when it is cold, which means that customers can practically always drive on more cheaply priced natural gas. Other systems have to use expensive gasoline to warm up in the starting phase.

Costing: In Germany, CNG powertrains in passenger cars pay off as soon as annual mileage exceeds 7,000 kilometers. This is also because CNG is as much as 50 percent less expensive than gasoline. Compared with a conventional gasoline engine, generating the same power causes 25 percent less CO₂ to be emitted. This is due to the chemical properties of this fuel source.

Diesel and natural gas: For commercial vehicles, Bosch offers a dual-fuel natural gas and diesel system. This system is compatible with CNG and LNG (liquefied natural gas), and allows up to 90 percent of diesel to be replaced by natural gas. Here, the diesel injection system acts like a kind of liquid spark plug. As it ignites the gas, there is no need for any additional ignition system.

Video link
[CNG powertrain](#)



Fleet customers: Compared with engines run purely on diesel, dual-fuel engines with a natural gas and diesel system emit 15 to 20 percent less CO₂, as well as less particulate matter. At the same time, natural gas is cheaper than diesel fuel. This makes the diesel-natural gas variant especially attractive for customers with fleets of heavy trucks. Vehicles fitted with Bosch dual-fuel systems can also be run purely on diesel, and are thus suitable for areas with a limited natural-gas infrastructure.

Infrastructure: “Natural-gas systems already have the potential for reducing CO₂ at low additional cost. Technologically, this is an area in which Bosch components lead the way. However, vehicles run on natural gas will only become more popular in the market if the infrastructure is significantly expanded.”

(Dr. Volkmar Denner, chairman of the board of management of Robert Bosch GmbH, responsible for research and development)

Flex fuel: driving on ethanol

Market: The lead market for ethanol-powered vehicles is Brazil. Approximately 87 percent of all vehicles newly registered there in 2012 run on alcohol. In 2013, the ten-millionth flex fuel vehicle was manufactured in Brazil. The reason for this is that the Brazilian government strongly promotes this alternative fuel. Other fuels, for example, must always contain a minimum of 25 percent ethanol. Other important markets for flex fuel vehicles are the U.S. and Sweden.

Cold start: The Bosch Flexstart system makes cold starts possible with pure ethanol (E100) even at temperatures below 15 degrees Celsius. Unlike conventional flex fuel systems, the Bosch system does not require any additional gasoline in order to pre-heat the ethanol. This task is assumed by glow plugs integrated in the fuel rail. They heat the ethanol prior to injection, making a cold start possible.

The challenge: Ethanol fuel poses considerable challenges for systems manufacturers, since the liquid can damage the installed components. For this reason, a special alloy is needed to protect parts such as pumps, rails, injectors, and even spark plugs. Calibration of the control unit is considerably more complex than with other combustion methods, requiring roughly 50 percent more effort.

[Video link](#)
[Flex fuel](#)



Emissions reductions: Compared with conventional ethanol systems, Flexstart technology helps prevent up to 40 percent of the emissions associated with starting the engine. This is because this Bosch component uses glow plugs to pre-heat the ethanol fuel before it is injected. Pre-heating makes the ethanol-air mix more combustible, averting emissions where they are most likely to occur: in the cold-start phase.

Well-to-wheel: Ethanol powertrains offer the greatest potential for CO₂ reduction from the well-to-wheel perspective – i.e. a calculation that considers the path taken by the fuel from production to combustion. In this context, Bosch regards the production of ethanol from organic waste as especially sustainable.

Press photos: 1-GS-19443, 1-GS-19444, 1-GS-19445

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Bosch Compact

Electrification of the powertrain

From entry-level hybrids to range extension to manufacturing in China

September 2013

PI 8262 GS FF/Moe

Electromobility: driving enjoyment and connectivity

Future market: At the moment, electromobility is still an investment in the future. Bosch spends 400 million euros each year in this area. Alongside fuel savings, the focus is on tangible customer benefits including driving enjoyment and added value in everyday life. Bosch is working on extending the range of conventional electric cars to at least 300 kilometers by 2020.

Focus on integrated systems: Where electric drives are concerned, Bosch looks at how individual powertrain components fit into the bigger picture. In particular, concepts are developed that encompass far more than just the battery, since not just larger batteries are essential to extending the range of electric vehicles, but also more intelligent networking. One example of this is intelligent charging management.

Examples of systems solutions: The SMG 180/120 electric motor has been developed to have an efficiency level of over 90 percent in city traffic, which is the most relevant type of traffic for electric cars. Apart from the powertrain, Bosch is linking electric driving with assistance functions. One example of this is the electronic horizon, which starts the energy recovery cycle in good time before the vehicle enters a speed-restricted zone, such as the outskirts of an urban area. By converting kinetic energy into electrical energy, it increases the vehicle's range.

Connectivity: “Electromobility is currently still a niche business, but after 2020 it could very well become a mass market. When that happens, electric vehicles will be connected vehicles, exchanging information with their surroundings.

(Dr. Volkmar Denner, chairman of the board of management of Robert Bosch GmbH, responsible for research and development)

Complete solutions for all-electric vehicles: Bosch already supplies electric drives as complete system solutions. These comprise an electric motor, power electronics, a lithium-ion battery system, and a regenerative braking system. An example of this can be found in the Fiat 500e, which is the result of an alliance with Fiat and Chrysler.

Video link
[Electric drive](#)



Pace of development: It took Bosch engineers three years to make electric drives market-ready. Since entering the market in 2010, Bosch has delivered components and systems to customers worldwide, for vehicles ranging from small cars to large sedans and super sports cars.

Alliances: Bosch collaborates with partners around the globe in order to drive electromobility forward worldwide. Examples include UAES in China (electric motors and power electronics), the joint venture EM-motive with Daimler in Germany (electric motors), and a joint venture with GS Yuasa and Mitsubishi in Japan (lithium-ion batteries).

E-mobility worldwide: Bosch has also succeeded in establishing bridgeheads for its e-mobility business in various regions of the world. In addition to lead engineering centers in Europe, there are also branch operations in the U.S. and Japan. Furthermore, Bosch is the only automotive supplier able to offer locally-manufactured versions of its complete portfolio of its electric motors and power electronics in China – on a quality level comparable to the European market.

Hybrids: already on track to becoming a vehicle for the masses

Market developments: By the end of 2014, Bosch will have completed 30 orders relating to powertrain electrification. Bosch forecasts that of a predicted 113 million total vehicles sold worldwide in 2020, 6.5 million will be strong hybrids, 3 million will be plug-in hybrids, and 2.5 million will be all-electric.

Boost recuperation system: This is Bosch's entry-level hybrid system for the mid-size segment. It is simultaneously the basis for the new 48-volt on-board electrics, since it operates at a higher voltage. The advantage of this is that fuel-saving coasting is possible, and regenerative braking can be used particularly efficiently. This results in fuel savings of up to 7 percent.

Strong hybrids: With the strong-hybrid systems currently made by Bosch, drivers can reduce their consumption in the new European driving cycle by 15 to 25 percent. Electric motors for strong-hybrid vehicles cover the range between 20 and 40 kilowatts. Lithium-ion batteries for strong hybrids have a capacity between 0.8 and 1.5 kilowatt hours.

Plug-in hybrids: These can reduce energy costs by up to 90 percent, provided users always remember to charge up at the socket. In the clearly-defined new European driving cycle, the fuel savings are at least 50 percent. In plug-in hybrids, the electric motor has an output of 30 to 80 kilowatts, and the battery stores up to 12 kilowatt hours. The system is particularly suited to mid-sized vehicles, electrified SUVs, and sports cars.

Bonus: The Bosch SMG 180/120 motor can also be mounted on a vehicle's rear axle. This would allow a front-wheel-drive vehicle's front axle to be driven by the combustion engine while the rear axle is driven by the electric motor. Such a setup means that customers also get the added benefit of four-wheel drive functionality in their hybrid. One example of this type of axle-split hybrid is the Peugeot 3008 Hybrid4, the world's first diesel hybrid. It was recently made ready for series production by PSA and Bosch.

Press photos: 1-GS-19447, 1-GS-19448, 1-GS-19449

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[Video link
Plug-in hybrid](#)



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Electronic clutch made by Bosch **eClutch saves fuel and makes driving easier** Cost-efficient system closes the gap between manual and automatic transmission

August 2013
PI 8221 GS FF/af

- ▶ Reduces real consumption in start-stop coasting by 10 percent
- ▶ Stop-and-go driving in first gear without engaging the clutch
- ▶ eClutch now makes hybridization possible in vehicles with manual transmission

Traffic congestion is bad enough at the best of times, but doubly irksome without automatic transmission. The reason is the constant switching between clutch, gas pedal, and brake. In stop-and-go traffic, the Bosch eClutch allows drivers using manual transmission to use first gear without using the clutch. They can simply use the brake and gas pedal, just like in an automatic transmission, without accidentally stalling the engine. This electronically controlled clutch closes the gap between automatic and manual transmission. In addition, the eClutch makes the coasting function possible, which saves fuel. Independently of the driver, the clutch decouples the engine from the transmission if the driver is no longer accelerating. The engine then stops. The result is a real fuel saving of 10 percent on average.

In terms of price, the eClutch costs significantly less than a conventional automatic transmission, and is thus an attractive alternative in the compact car segment, where price competition is tough. Unlike a full-blown automatic transmission, the e-Clutch automates the clutch only, not the transmission. The clutch pedal transmits an electric signal to an actuator, which decouples the clutch.

The principle behind the start-stop coasting function is simple. The Bosch system detects the driver's easing of pressure on the gas pedal, decouples the engine from the transmission, and thus prevents the engine from

[Video-Link
Start/Stop Coasting](#)

consuming fuel. Drivers can already manually simulate this effect by disengaging the clutch on a downhill stretch. In the future, the system will automatically assume this function, while stopping the engine at the same time. This is technically sophisticated, but worthwhile, leading to a 10 percent reduction in fuel consumption.

Helping prevent jerky gear shifts

As well as the stop-and-go function and the possibility of saving fuel, the eClutch offers a number of other functions. For example, it can be used to support gear shifts, making them smoother. A special sensor detects the start of a gear shift and adjusts engine speed. The result is a smooth, easy gear change.

And if the powertrain is electrified, the electronically controlled clutch means that a combination of hybrid powertrain and manual transmission is now possible. Depending on the configuration, the system can enable coasting and recuperation. In this respect, the eClutch offers two advantages: manual transmission is still possible in hybrid vehicles, and the price of entry-level hybrids can be reduced, since a fully automatic transmission is no longer necessary.

Press photo: 1-GS-19393

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Bosch push belt

Continuously variable transmissions on the rise worldwide

September 2013

PI 8264 GS FF/Moe

- ▶ An easier drive consuming up to 7 percent less fuel thanks to continuously variable transmissions
- ▶ One quarter of all automatics will soon feature continuously variable transmissions
- ▶ Bosch technology is suitable for vehicles with up to 450 Newton meters of torque and more than 300 horsepower (220 kilowatts)

Driving up a winding mountain road can be a tiresome task. None of the gears seems to be right. Sometimes they are too high, sometimes too low. With continuously variable transmission, it's a different story. As its name suggests, this automatic transmission works without any fixed shifting point. The result is a smooth drive at constant traction and engine speed.

“With its smooth and dynamic acceleration, continuously variable transmission makes driving easy and enjoyable,” says Stefan Seiberth, the president of the Bosch Gasoline Systems division. “CVT especially comes into its own in urban stop-and-go traffic. It can reduce fuel consumption by as much as 7 percent, since the engine is constantly kept at its most efficient operating point.” Bosch manufactures the push belts that are a central component of CVT. They make it possible for the transmission to drive engines with a torque range between 60 and 450 Newton meters and an output of more than 300 horsepower (220 kilowatts). Using an electronic control, a number of different settings are possible, from economical to sporty.

In addition, the continuously variable transmission is extremely compact, since it comprises just a few components. The control unit, for example, can be integrated directly into the system. The compact construction keeps the manufacturing cost down, and also means that this transmission

[Video link](#)
[Continuously variable transmission](#)



fits into small urban vehicles. This also explains why CVT is especially popular in Japan. However, its market share is also growing in China and North America. Currently, every fifth automatic in the world is equipped with CVT. In just a few years, this share will grow to one-quarter. The technology is currently available in some 300 production models.

Flexible, yet as rigid as a solid steel rod

Bosch is also benefiting from this increase in market share. In 2012, the automotive supplier manufactured its 25 millionth CVT push belt. The component comprises hundreds of specially punched steel elements, stacked together in a high-alloy steel ring package. This design makes the push belt very flexible, but at the same time as rigid as a solid steel rod. This means that the Bosch component is very adaptable. It does not have to be developed separately for each vehicle, but often requires some adjustment only.

The way a CVT works is always the same. It closely resembles a set of bicycle gears: when the transmission ratio is higher, the diameter of the belt is larger on the drive shaft and smaller on the driven shaft. When the transmission ratio is lower, the situation is reversed, with a smaller belt diameter on the drive shaft and a larger one on the driven shaft. This stepless adjustment is made possible by the movement of the push belt. On both the drive and driven shaft, it moves between two cones that face each other. Depending on engine speed and torque, these pairs of cones alter the diameter traveled by the belt. In this way, there is always an optimum balance between required torque and engine speed.

Continuously variable transmissions are equally suitable for diesel, gasoline, and hybrid powertrains. And while this technology saves fuel in classic internal-combustion engines, it can also increase hybrid powertrains' electric range. This is because the CVT allows the internal-combustion engine to run at a higher speed, close to the optimum operating point. As a result, part of the energy released can be used for forward propulsion, while the rest can be stored in the rechargeable battery.

Press photos: 1-GS-19452, 1-GS-19453, 1-RB-17563-e

More information about continuously variable transmissions is available online at: <http://bit.ly/14l8uO9>

Video link
[Push belt](#)



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Automotive Technology is the largest Bosch Group business sector. In 2012, its sales came to 31.1 billion euros, or 59 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. Its roughly 177,000 Automotive Technology associates worldwide mainly work in the following areas of business: injection technology for internal-combustion engines, alternative powertrain concepts, efficient and networked powertrain peripherals, systems for active and passive driving safety, assistance and comfort functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, and concepts, technology, and service for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP® anti-skid system, and common-rail diesel technology.

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Boost recuperation system

Bosch is making hybrids affordable

Electric components provide a ten kilowatts boost while lowering CO₂ emissions by up to 15 percent

June 2013

PI 8152 SG Hn

- ▶ Recovery of braking energy and torque boost
- ▶ Silent and zero-emissions coasting for up to 30 percent of the journey
- ▶ Easy integration into vehicles of any class

The new Bosch boost recuperation system (BRS) is set to close the persistent and sizeable gap between start-stop systems and hybrid drives. “BRS represents the affordable electrification of compact cars,” says Wolf-Henning Scheider, member of the board of management of Robert Bosch GmbH. “We are serving the needs of the mid-price segment by providing tailored components such as a lithium-ion battery with a capacity of 0.25 kilowatt-hours.” BRS can lower a vehicle’s fuel consumption and CO₂ emissions by up to 15 percent thanks to electrical components that provide the engine with up to ten kilowatts of additional power. This opens up another way to meet more demanding CO₂ emissions restrictions in Europe, China, and the United States.

This innovative Bosch drive component combines four functions within one system: recuperation and torque boost together with comfortable start-stop and coasting functions. The centerpiece of this new hybridization is a highly efficient generator that has been upgraded from 12 to 48 volts using new power electronics, making the electric motor up to four times more powerful than before.

This 48-volt electrical system offers drivers a range of benefits. Increasing the voltage allows vehicles to be fitted with new comfort and security systems. And as mechanics do not need special high-voltage training before they can service BRS, it is easier to maintain than current hybrid systems.

BRS charges during braking and delivers additional torque when accelerating

As its name suggests, the boost recuperation system performs two main functions: it uses recuperation to recover energy and then uses that energy for vehicle acceleration. In detail, it works as follows: any surplus energy from braking is sent via the 48-volt vehicle electrical system to the 0.25 kilowatt-hour lithium-ion battery. When required, this energy is fed back to the BRS, which then functions as an electric motor. This means BRS provides additional torque – a boost effect that is particularly important for achieving dynamic handling with small, turbocharged engines and at low engine speeds.

The new system also expands the familiar start-stop system to enable coasting. If neither the accelerator nor brake pedal is depressed while coasting to a stop or going slightly downhill, BRS automatically stops the internal combustion engine. The vehicle coasts along driven solely by its momentum, producing no emissions and no noise. Freeways and highways that slope gently downward provide ideal driving conditions for BRS coasting. Under real conditions such routes offer the chance to coast for 30 percent of the journey.

The comfort of a start-stop function and silent starting

The boost recuperation system also takes the start-stop function to the next level by rapidly starting the vehicle's engine with no noise or jolts, even when restarting the combustion engine during coasting. Once again, the 48-volt battery helps by reliably bridging these driveless periods to provide power to all comfort and safety functions.

New vehicle electrical system architecture with DC/DC converter

With its additional functions, the 48-volt electrical system is a particularly attractive solution for midsize and luxury vehicles, as it permits electrification of vehicle functions that could not be supported by a system with lower voltage and energy. It can, for example, increase the functionality and reduce the CO₂ emissions of air-conditioning compressors, turbochargers, engine-cooling fans, and auxiliary heaters. A bidirectional DC/DC converter – known as the power conversion unit, or PCU for short – connects the new 48-volt electrical subsystem to the conventional 12-volt system with a high degree of efficiency and reliability. The PCU's main job is to supply this 12-volt electrical system with electrical energy produced and stored on the 48-volt part of the system. The PCU is compact and can be flexibly installed in the vehicle, even the engine compartment.

Press image: 1-SG-19206

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More information is available online at www.bosch.com and www.bosch-press.com



The new powerhouses

Bosch Power Density Line generators

Small, light, and compact thanks to high power density

September 2013
PI 8265 SG Hn/af

- ▶ High efficiency of up to 80 percent
- ▶ Extremely low noise levels
- ▶ “Local for local” availability on a global scale

The latest addition to the range of Bosch generators once again reflects the trend toward increasingly compact and lightweight vehicle components. “The compact Power Density Line (PL) generator combines proven technology with innovative components,” says Dr. Ulrich Kirschner, president of the Bosch Starter Motors and Generators division. By developing a new flat pack winding technique for the stator, the Bosch engineers have achieved unprecedented power densities while at the same time significantly reducing the component’s copper content. “The PL series of generators fulfills the demanding requirements of high-end carmakers,” adds Kirschner.

The new PL generator is scheduled to go into series production in 2014, with a choice of models ranging in output from 1.5 to 3 kilowatts.

Small footprint and high performance

The exceptionally high power density of the PL generator allows it to be installed in even the most confined spaces of the engine compartment. Its diameter ranges from 134 to 144 millimeters – depending on the variant – and it delivers an output of between 130 and 250 amps at an engine speed of around 2,000 rpm. All models are capable of withstanding engine compartment temperatures of up to 125°C.

Optimized for lower fuel consumption and CO₂ emissions

The efficiency of the new PL product range is on par with that of the Bosch Efficiency Line generators. Efficiency of 76 or 80 percent can be achieved through the use of high-efficiency diodes (HED) or active rectification (SAR), both available as an option. These features reduce the mechanical energy the generator requires in order to generate power for the electrical consumers in the vehicle. The generator's high efficiency and ten-percent lower weight compared to today's models will help vehicle manufacturers to achieve further reductions in fuel consumption and CO₂ emissions.

If the generator control unit is equipped with an analog or digital communications interface such as LIN (Local Interconnected Network), it is possible to implement smart functions that enable a higher proportion of the electrical energy to be generated during vehicle coasting, resulting in additional fuel savings of up to two percent.

Extremely low noise levels

Reducing the noise transmitted to the interior of the vehicle is a particularly important concern in the high-end segment. Here too, the performance of the new range of PL generators has been optimized compared to its predecessors. The use of the five-phase winding significantly reduces magnetic noise, especially when the engine is running at low speed, for instance during idle. Aerodynamic noise at high engine speeds has been almost halved by modifying the design of the generator cooling fan.

Global availability from the beginning

Production of the new generators will be launched in Europe and Asia in early 2014, and shortly afterwards in North America. This schedule ties in with the continuing globalization of vehicle platforms. Bosch associates in each region will be responsible for adapting applications to local requirements. This approach enables Bosch to offer high-quality products to customers throughout the world that meet the highest quality standards and at the same time can be adapted to the needs of specific regional markets.

Press photos: 1-SG-19462, 1-SG-19463

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The new C60 series **Bosch builds the world's smallest starter for passenger cars**

September 2013
PI 8266 SG Hn/af

- ▶ For gasoline engines with up to two liters of engine displacement
- ▶ Developed in the company's global network
- ▶ Production to start in September 2013

With its compact size and its outer diameter of just 60 millimeters, the Bosch C60 is the world's smallest starter for passenger cars. It is available in three versions, which range from 0.8 to 1.2 kilowatts in power. It is designed mainly for gasoline engines with an engine displacement of up to two liters, but can also be used in small diesel engines with reduced drag torque. Weighing just two kilograms, the C60 is about 25 percent lighter than currently available products, making it a global benchmark. The C60 series, which can also be used with start-stop applications, makes starting a car comfortable and quiet.

Growing global market share of small gasoline engines

The C60 is designed for small gasoline engines with an engine displacement of up to two liters. This segment currently accounts for some 70 percent of the global market, and is continuing to grow. The growing share of low-cost compact cars in the world's emerging markets is one of the drivers of this development. Thanks to its lightweight and compact design, the C60 is particularly well suited to this segment.

Less is more

By combining the planetary gearbox with the overrunning clutch, power requirements have been reduced and the relay resized accordingly. As a result, the voltage dip associated with starting the car has been minimized. Moreover, thanks to the armature's improved electrical design, copper content has been reduced by one-third, and the starter's compact dimensioning also means a similar reduction in the amount of aluminum

and steel required. The C60's design makes it suitable for conventional and start-stop applications in a wide range of engine platforms worldwide. This saves automakers calibration work and enables standardized production in the global Bosch manufacturing network.

A global set-up from the very start

Bosch engineers in Germany, China, Brazil, and India worked together to develop the C60 in the company's global network. Production is scheduled to begin in September 2013 in China, where Bosch will supply the C60 to a major local customer. Shortly after, the compact and particularly efficient starter will also be produced in Germany, Brazil, and India.

Press photo: 1-SG-19457

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Facts about driver assistance
Enhanced driving safety and comfort

December 2014
PI 8202 BBM joe/SL

Assistance systems make driving safer by giving warnings and support in critical situations. They also look after humdrum, repetitive tasks. As one of the world's largest providers of mobility solutions, Bosch is actively driving forward their development. It has all the necessary technologies in its portfolio and is working intensively on networking them, so that it can offer even more powerful functions for increased safety and comfort. Ever more automated driving functions will help us reach "vision zero," the goal of eradicating road fatalities.

For greater safety, there are predictive emergency braking, lane assistance, and drowsiness detection systems, as well as predictive pedestrian protection. For greater comfort, there are parking assistance and night vision systems, road sign recognition, and a traffic-jam assist function. More than 5,000 Bosch engineers around the world are constantly working on new systems. Sales generated with driver assistance systems will exceed the billion-euro mark by 2016.

Driver assistance is booming – and Bosch along with it

In the future, Euro NCAP will award its top rating of five stars only to vehicles with driver assistance functions: from 2014, vehicles must have at least one predictive assistance system based on sensors that monitor the vehicle's surroundings; from 2016, they must also have predictive pedestrian protection. This will trigger an additional burst of growth. Car buyers prize assistance systems whose benefits they feel every time they get behind the wheel. Consequently, automakers market them as a feature to set their vehicles apart from the competition. Between the start of series production in 2000 and 2014, Bosch manufactured a total of two million 77-gigahertz radar sensors. The ten million milestone will likely be reached in 2016. Sales of Bosch video sensors doubled from 2013 to 2014. In 2014, Bosch produced nearly 50 million ultrasound sensors, 25 percent more than the previous year.

The goal: to reduce the number of road fatalities worldwide

The UN predicts a global increase in road fatalities from 1.3 to 1.9 million in the decade from 2010 to 2020 – a rise of almost 50 percent. Well over 100,000 people die on Indian roads every year – and sadly, the trend shows no sign of abating. In the United States, the number of road accident victims fell from 42,000 in 2000 to just under 33,000 in 2011. In Europe, the number of road fatalities decreased from 54,000 in 2001 to 30,300 in 2011.

Bosch driver assistance milestones – a long tradition of expertise

- 1978: the world's first commercially viable antilock braking system (ABS)
- 1980: the world's first electronic airbag control unit
- 1984: antilock braking system for motorcycles
- 1989: Bosch "TravelPilot" – Europe's first navigation system
- 1993: ultrasound-based parking aid
- 1995: World's first ESP electronic stability program
- 2000: radar-based adaptive cruise control (ACC)
- 2008: semi-automatic ultrasound-based parking assistant
- 2010: the world's first ultrasound-based blind-spot detection system
- 2010: predictive emergency braking system
- 2010: road sign recognition
- 2010: lane-departure warning systems
- 2013: electromechanical brake booster (iBooster)
- 2014: mid-range radar sensor for rear-end applications

The Bosch driver assistance portfolio

Brake control systems: The electronic stability program (ESP) stabilizes a vehicle when it goes into a skid and can brake the vehicle autonomously in defined situations. The iBooster electromechanical brake booster, which went into production in late 2013, is the future of brake boosting technology. It works without a vacuum and provides situation-dependent support when the driver initiates braking. Moreover, electric vehicles fitted with the iBooster attain particularly high recuperation levels, while assistance systems benefit from its rapid and quiet response.

Electric steering systems: In these products, which are manufactured by the joint venture ZF Lenksysteme GmbH, the degree of steering support can be varied using the system software. The steering system is capable of making automatic stabilizing interventions, and in this way complements the ESP. This makes it a further essential building block for future assistance systems.

Sensors: They are the vehicle's sensory organs.

Radar sensors measure very precisely the distance and speed of other vehicles up to a range of over 200 meters, making them the ideal basis for adaptive cruise control and predictive emergency braking systems. For its radar sensors, Bosch exclusively uses the high-capacity 77-gigahertz frequency band, which has been permanently allocated to automotive applications worldwide. The year 2013 saw the launch of a new, cost-effective generation of the mid-range radar sensor, which is available for use at the front and rear of vehicles.

Video sensors are capable of recognizing anything from road signs and markings to pedestrians and cyclists. The new Bosch stereo video camera has binocular vision and can therefore measure distances. This single-sensor solution covers all new Euro NCAP requirements.

Wide-angle video sensors are being increasingly used for parking and maneuvering assistance functions. Because these sensors permit a 360° view (bird's eye view), they cover the entire close-range area around the vehicle.

Ultrasound sensors: Based on the way bats find their way in the dark, this technology is cost-effective and has been successfully used in parking assistance systems to measure distances for two decades now.

Networked navigation:

Highly efficient assistance systems and wide-ranging automated driving functions require precise map data that is regularly updated via an online connection. The "electronic horizon" can already supply precise information about the route, including road gradients and bend curvatures. Networked vehicle functions use this data to reduce fuel consumption, while electric vehicles use it to extend their range.

User interfaces:

A key to the success of assistance systems is their user interfaces. If assistance functions are to take over progressively wider-ranging driving tasks, they must be intuitive and easy to operate. Consequently, Bosch studies and weighs up the different possible approaches and uses a variety of solutions, including freely programmable display systems and head-up displays. In the future, new visualization methods based on augmented reality will be used to realistically superimpose information such as driving recommendations and proximity warnings onto the actual current traffic situation. Multimodal concepts are another approach to user-friendliness. These interfaces react to gestures, touch, and voice input.

Quotes on the subject of driver assistance

“In each of the years up to 2017, the market for driver assistance is set to grow by a third. And Bosch is set to grow even more strongly,” says the Bosch board of management member Wolf-Henning Scheider.

“Driver assistance will experience a real boom in the coming years,” says the Bosch board of management member Wolf-Henning Scheider.

“Stereo technology allows us to open up new potential for video-based safety systems,” says Gerhard Steiger, president of the Bosch Chassis Systems Control division. “A mono video camera requires extensive ‘training’ before it can distinguish between different types of objects – such as pedestrians and cars – in its image field. By contrast, a stereo video camera can measure and detect all obstacles based on their movement and distance alone.”

“Assistance systems make driving safer, more eco-friendly, and more relaxing,” says Gerhard Steiger, president of the Bosch Chassis Systems Control division.

“Ultrasound, radar, and video – Bosch has all the sensor technologies needed for driver assistance,” says Steiger, “and together with its braking and steering systems and its core competence in vehicle integration, this gives the company an excellent basis for developing new, even more powerful assistance systems.”

Press photos: 1-CM-17945, 1-CC-18791, 1-CC-18794, 1-CC-19153,
1-CC-19219

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Mobility Solutions is the largest Bosch Group business sector. In 2013, its sales came to 30.6 billion euros, or 66 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers (NB: Due to a change in accounting policies, the 2013 figures can only be compared to a limited extent with the 2012 figures). Mobility Solutions largely operates in the following areas: injection technology for internal-combustion engines, alternative powertrain concepts, efficient and networked powertrain peripherals, systems for active and passive driving safety, assistance and comfort functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, and concepts, technology, and service for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP anti-skid system, and common-rail diesel technology.

The Bosch Group is a leading global supplier of technology and services. In 2013, its roughly 281,000 associates generated sales of 46.1 billion euros. (NB: Due to a change in accounting policies, the 2013 figures can only be compared to a limited extent with the 2012 figures). Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 360 subsidiaries and regional companies in some 50 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. In 2013, the Bosch Group invested some 4.5 billion euros in research and development and applied for some 5,000 patents. This is an average of 20 patents per day. The Bosch Group’s products and services are designed to fascinate, and

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Fourth-generation long-range radar **Bosch presents new radar sensor** Basis for high-performance assistance systems

August 2013

PI 8268 CC Ks/af

- ▶ Wider aperture allows faster reaction when cars cut in front
- ▶ Height now also measured for improved emergency-brake function
- ▶ Standardized manufacturing processes reduce manufacturing cost

Many high-performance assistance systems use a radar sensor to map the vehicle's surroundings. The advantage of these sensors is that they can measure extremely accurately the distance and speed of vehicles on the road ahead. Bosch has now developed a new long-range radar sensor. Like its predecessors, it uses the 77-gigahertz frequency bandwidth. It is also even more powerful, compact, and cost-effective than its direct predecessor. "The new radar sensor can detect obstacles and vehicles cutting in even faster," says Gerhard Steiger, president of the Chassis Systems Control division. "This means that safety functions such as automatic emergency braking can be triggered earlier." The fourth generation of Bosch long-range radar sensors, or LRR4 for short, goes into series production in 2014.

Wider aperture provides more information about surroundings

The most important technical novelty in the new LRR4 is the number of radar beams used. As in the predecessor model, four generate a bundled beam to the front. They can detect other vehicles at a distance of roughly 250 meters. This allows the ACC adaptive cruise control to be used at speeds of more than 160 kph, and the ACC can make up for large differences in speed without any intervention by the driver. Two additional radar beams extend the aperture to 40 degrees – ten degrees more than the predecessor. This means vehicles cutting in can be detected even earlier, and the ACC can react faster. For even more information, there is also an elevation beam. In concert with the six basic beams, it can estimate the height of the objects detected, which helps to classify them better.

The advantage for drivers is that critical situations, especially in urban traffic, are detected and clearly identified earlier. Automatic emergency braking can be triggered earlier, meaning that accidents can be averted altogether or their severity mitigated. Maximum performance comes from the use of two radar sensors installed one on each side of the front of the vehicle. Together, they offer an even wider aperture. As they are not installed dead center, they can detect vehicles cutting in even quicker.

LRR4 integrates comprehensive sensor data fusion

Powerful assistance systems frequently rely on more than one sensor. Like its predecessor, the LRR4 can use its own control unit to process the data from a second, optional radar sensor, from a video camera, and from ultrasound sensors. With the help of powerful software algorithms, this “sensor data fusion” can give rise to a highly detailed “image” – or more precisely, an interpretation of the vehicle’s surroundings. By this, it also detects pedestrians and includes them in its evaluation of the situation, which can help further improve functions such as automatic emergency braking. From 2016, this pedestrian protection will be one of the requirements of the safety tests carried out by the consumer protection organization Euro NCAP. The benefit of such systems has already been proved by the euroFOT field study, initiated by the European Union. Published in 2012, it found that an ACC in combination with a collision warning system can have a positive effect on more than five percent of all freeway accidents involving injury, or even avert them altogether.

Like its predecessor, the LRR4 does not have any moving parts. This makes it especially robust, and suitable for all types of passenger car. And with optional lens heating, this function is practically always available, even in ice and snow. The high-frequency module makes use of silicon-germanium technology.

The manufacturing process also features an innovation: all components can now be manufactured using standard soldering processes. This further reduces manufacturing cost. “With its many innovations, Bosch has made radar sensors more powerful and cost-effective,” Steiger says. “Radar technology is ready for the mass market.” This is underscored by the planned manufacturing volumes at Bosch. From start of series production in 2000, it took until early 2013 to manufacture the first million. The second million, by contrast, will roll off the production lines in 2014, and the ten-millionth sensor is scheduled to follow just two years later.

As an alternative to long-range radar sensors, Bosch has been offering mid-range radar sensors since mid-2013. These are even more cost-effective, with a shorter range of 160 meters. They allow automatic emergency braking and adaptive cruise control at speeds of up to 160 kph, which is sufficient for most countries. A variant for use at the rear of the vehicle will be launched in 2014. At an early stage, this sensor detects vehicles approaching fast from the rear, and can warn of a collision when changing lanes. With an aperture of 150 degrees, it covers an especially wide field of view.

Press photo: 1-CC-19436

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The new Bosch iBooster **Intelligent control boosts braking power** Basic system for electromobility and driver assistance

June 2013

PI 8143 CC Ks/SL

- ▶ Achieves greatest possible mileage by recuperating almost all braking energy in hybrid and electric vehicles
- ▶ Shortens braking distance in autonomous emergency braking by building up pressure three times faster
- ▶ Allows tailoring of brake pedal feel thanks to freely programmable characteristic curves

In recent years, car braking systems have become ever more powerful. ABS and ESP in particular have significantly increased safety. Over the same period, however, the standard vacuum-based approach to boosting brake force has remained almost unchanged. Until now, there has been limited scope for recovering braking energy; and the driver's pedal force can only be amplified by a single predetermined degree. Now Bosch has developed the iBooster, an electromechanical brake booster that provides situation-dependent support when the driver initiates braking. "The iBooster makes hybrid and electric vehicles even more efficient, while enhancing safety through shorter braking distances," says Gerhard Steiger, president of the Bosch Chassis Systems Control division. What is more, the iBooster complements a modular range of components from which Bosch can put together a suitable braking system for any vehicle configuration. Production of this innovation will start in 2013 for three series-produced models. Over the medium term, it will displace conventional brake boosters in many vehicles.

Increasing energy recovery to increase range

If hybrid and electric vehicles are to achieve their intended range and fuel efficiency, they must recover as much electrical drive energy as possible when braking. Ideally, cars would be slowed down purely as a result of their electric motor converting their kinetic energy into electricity. This

would avoid the loss of valuable energy through braking. The Bosch iBooster recovers almost all the energy lost in typical braking operations by ensuring deceleration rates of up to 0.3 g are achieved using the electric motor alone. It thus covers all common braking maneuvers in everyday traffic. If the brakes to be applied harder, the iBooster generates the additional braking pressure needed in the traditional way, using the brake master cylinder. The driver does not notice this harmonious interplay of motor and brakes, as pedal feel remains absolutely normal.

Bosch has integrated a motor into the iBooster to control the degree of brake boosting via a two-stage gear unit for situation-dependent support on demand. This dispenses with today's costly, continuous process of generating a vacuum using either the internal combustion engine directly or a vacuum pump. Not only does this save fuel in itself, it also allows more comprehensive use of fuel-saving functions that stop the engine for periods of time, such as start-stop or coasting.

More safety and more comfort

The electromechanical concept offers further advantages. Should the predictive emergency braking system detect a dangerous situation, the iBooster can build up full braking pressure autonomously in a mere 120 milliseconds or so – three times faster than previous systems. In emergency situations, therefore, the iBooster can brake the vehicle faster than a driver using a conventional braking system. The iBooster can also take on the ACC's job of gently bringing the vehicle to a standstill, and do so comfortably and noiselessly. This is particularly compelling for quiet e-vehicles, since ambient sounds are much more noticeable in their interior.

The ability to define characteristic braking curves gives developers the freedom to determine pedal feel and adapt it to the customer's brand-specific wishes. If the vehicle also offers driving modes such as sport, comfort, or economy, the brakes can be made to react more softly or more aggressively as appropriate. Situation-dependent support is also possible, for instance during emergency braking.

Modular approach ensures suitability of braking system

The iBooster is part of a modular range of components from which Bosch can easily put together a suitable braking system for all cars and all customer requirements – whatever the vehicle size, powertrain technology, and degree to which the vehicle is equipped with assistance functions. For brake boosting, the modular system offers the iBooster or the

conventional, vacuum-based solution. For the brake control system, the choice is between a standard ESP or the ESP hev, which has been designed specifically for use in hybrid and electric vehicles. Especially for vehicle models that are offered with a choice of powertrain, this Bosch modular approach is so far unrivaled.

Increased flexibility for automakers

As the number of different models and drive systems on offer rises, so too does the complexity of the underlying technology. Thanks to its freely programmable braking performance curve, identical Bosch iBoosters can be installed in different variants of a vehicle model and still offer tailored characteristics. Programming is quick and easy at the end of the production line, and it is easy to vary the installation to suit right-hand-drive or left-hand-drive models. The booster unit itself is purely electromechanical, without brake fluid, which means it can be rotated flexibly about the longitudinal axis. Consideration has also been given to the future of car driving: in combination with Bosch ESP, the system offers the level of braking-system redundancy that is needed for safety reasons in automated self-driving cars.

Press photo: 1-CC-19196

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Lightweight and available worldwide **Bosch presents new aluminum brake booster**

September xx, 2013

PI 8270 CC Ks/af

- ▶ Weighs about half as much as traditional brake boosters made from steel
- ▶ Aluminum versions of Bosch Tie Rod 4 vacuum-based brake booster
- ▶ Worldwide production for global vehicle platforms

The lighter the vehicle, the less fuel it consumes and the more dynamically it can be driven. In their quest to reduce vehicle weight, automakers and their suppliers are increasingly replacing conventional steel with lighter metals. An example of this is the Bosch Tie Rod 4 vacuum brake booster, which the technology supplier now offers in various aluminum models. “The new aluminum versions of our brake booster are only half as heavy as conventional steel ones,” says Gerhard Steiger, the president of the Bosch Chassis Control Systems division. “Depending on the size, this means a weight saving of up to 1.5 kilos compared to earlier models.” The weight-reduced versions of the Bosch brake booster will feature in three production-vehicle models later this year.

When Bosch engineers introduced the steel Tie Rod 4 in 2011, they had already succeeded in significantly reducing its weight compared to previous models. The new aluminum brake booster from Bosch is now even lighter. It is available as a single model with a 10-inch or 11-inch diameter or as a tandem version with a diameter of 8+8 or 8+9 inches. Other versions are available on request. Although the thickness of the walls has been reduced in the aluminum models, rigidity is ensured by the integrated tension rods. This rigidity is essential for a good pedal feel as well to keep pedal play to a minimum.

A “through-bolt” version is also available, which means that any mounting work can be done exclusively from the engine compartment. As with all Bosch brake boosters, the system is complemented perfectly by the Bosch TMC 8e brake master cylinder. This is 20 percent lighter and 30 percent shorter than its predecessor.

All versions of the Tie Rod 4 can be manufactured worldwide. This means Bosch is able to offer automakers standardized solutions, especially for global vehicle platforms.

Press photo: 1-CC-19454

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High degree of energy recovery lowers fuel consumption

September 2013

PI 8271 CC Ks/af

Bosch ESP hev brake control system for hybrid and electric vehicles

- ▶ In combination with electrical powertrains, new brake control system enables a high degree of energy recovery
- ▶ ESP hev coordinates the braking from the wheel and electric motor without the need for additional components
- ▶ First series application in Mercedes-Benz S400 Hybrid
- ▶ Bosch modular kit provides the right braking system for every vehicle

In the future, large vehicles in particular will need electrified powertrains in order to comply with ever-stricter consumption limits. The efficiency of these hybrid and electric vehicles will in large part be determined by their ability to recover as much energy as possible while braking. Bosch's ESP hev is the world's first series-produced brake control system that coordinates the braking from the wheel and electric motor without the need for additional components, recovering a particularly high proportion of braking energy in the process. The system debuted in mid-2013 in the Mercedes-Benz S400 Hybrid. "Using ESP hev, all the braking maneuvers defined in the New European Driving Cycle (NEDC) can be fully exploited for energy recovery," says Gerhard Steiger, president of the Bosch Chassis Systems Control division. "The new technology is part of our modular brake kit, with which we can put together a customized braking system for any vehicle."

High level of energy recovery thanks to decoupled axle

In the S400 Hybrid, the Bosch ESP hev coordinates the hydraulic and motor brake torque, and controls the electric vacuum pump of the vacuum-based brake booster. The brake circuit on the driven rear axle is decoupled from the driver's foot. By deliberately giving the brake pedal greater play,

the vehicle can initially be braked solely by the electric motor connected to the rear axle, generating electricity. The position of the pedal tells the system how much generator torque is needed. If the driver steps harder on the brakes, additional hydraulic brake torque is built up on the front axle in the usual way, so that braking force is now applied to both axles of the vehicle. If the generator cannot provide enough brake torque on the rear axle, the system uses the pump of the hydraulic modulator to build up additional brake pressure. The transitions are smooth and imperceptible for the driver – the vehicle's behavior and pedal feel remain unchanged.

Along with the version described above for brake circuits with front and rear axle distribution, Bosch also offers a version for diagonal brake circuits. ESP hev can also be used in vehicles with front-wheel or four-wheel drive. The new braking system is based on ESP premium, the most powerful of the variants of Bosch Generation 9.

Modular kit offers the right braking system for every vehicle

ESP hev is part of a kit from which Bosch can put together a customized braking system for all vehicles and customer needs, taking criteria such as vehicle size, type of powertrain, degree of electrification, and number of assistance functions into consideration. While ESP hev is the regenerative braking solution for hybrid and electric vehicles, classic ESP continues to be the solution for conventional vehicles. There are also two brake-booster alternatives: the conventional vacuum-based solution and the iBooster. This new electromechanical brake booster does not need a vacuum, and in combination with ESP hev it can improve energy recovery even further – all the while providing excellent pedal feel. In addition, the iBooster offers the system redundancy that is essential for future automated driving functions. It will go into series production at the end of 2013. In other words, Bosch offers automakers an unrivaled modular and scalable solution package, which is especially suitable for vehicle models that are available with different powertrains.

Along with the ESP system, Bosch supplies other components for the different models of the new Mercedes-Benz S-Class, including the direct injection systems for gasoline and diesel engines, the display in the middle console, the start-stop starter, and the engine's cooling fan.

Press photo: 1-CC-19517

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Bosch Compact **Parking assistance systems** Safe, stress-free parking and maneuvering

September 2013
PI 8269 UBK Ho/af

For many drivers, parking is often very stressful. Ever less room to maneuver, tighter spaces, and frantic traffic conditions make it an increasingly difficult task. Parking, and the maneuvering that goes with it, is also still a risky undertaking. An analysis of accident data from the AZT, a German accident research institute, shows that roughly half of all traffic accidents in Germany involving vehicle damage are a result of collisions while parking. This is where parking assistance systems can help. They help drivers park and maneuver their cars safely and comfortably. Bosch is a leading supplier in this segment.

Parking aid: better overview while parking

The Bosch parking aid offers help in situations where every centimeter counts. Using sensors integrated into the vehicle's bumper, the system monitors the area immediately ahead of and behind the vehicle, and recognizes obstacles in good time. Just like bats, sensors send out ultrasound signals and pick up their echo. The system uses the time difference between these two signals to calculate the distance between the vehicle and obstacle, which it can do from up to 2.5 meters away. Depending on the type of car and system, it either sounds an alarm or combines an alarm with a visual warning signal to the driver. In the alarm-only version, the distance is indicated with a progressive tone alert which increases in frequency the closer the car gets to an obstacle, finally becoming continuous. Optical-acoustic systems start by visually indicating the vehicle's proximity to an obstacle using LED displays or an on-screen image, and accompany this with an alarm when the car gets too close (approximately 30 centimeters or less). This way, even the tightest parking spaces no longer present a problem. The parking aid can prevent annoying and costly repairs for damage caused while parking. In most cases, it pays for itself with the first collision it prevents.

Parking assistant: like being guided on rails

Unsuccessful parking attempts are frustrating and nerve-wracking. The Bosch parking assistant gets drivers into any suitable parking space within seconds – without any stress or hassle. A special sensor integrated into the side of the front bumper scans the side of the road as the car drives past. The parking assistant lets the driver know immediately when it finds a suitable parallel or perpendicular space. If the driver presses the button to activate the parking assistant, the system takes just fractions of a second to calculate the optimum path into the space, the necessary steering movements, and the number of maneuvers needed. Then the parking assistant takes control: the driver lets go of the steering wheel and controls the parking maneuver by carefully accelerating and braking. With the support of electric power steering, the assistant performs all the steering movements and guides the vehicle into even the tightest of spaces – as though it were on rails. The driver remains in control throughout, and can abort the maneuver at any time by simply taking hold of the steering wheel. In addition, the assistant also helps with pulling out of the parking space. It steers the car into a position from which the driver can safely and quickly pull out of the space. The driver keeps an eye on traffic, and brakes or accelerates as directed by the system.

Automatic parking assistant: perfect parking in tight spaces – with no one at the wheel

In 2015, the Bosch automatic parking assistant will have its market debut. The system enables fully-automatic parking into and out of selected parking spaces. Drivers are free to focus solely on controlling the process. They decide if they want to remain in the car or get out ahead of time. Even spaces so tight that the car doors will barely open will soon be no hindrance. In this case, drivers can get out of their car in front of the selected space and start the parking maneuver remotely, for example by pressing a button on their car key or smartphone. The vehicle then parks and pulls itself out of the space on its own, without the need for anyone at the wheel. To interrupt the maneuver, the driver simply takes their finger off the button.

Reversing camera system: a new perspective on parking

Many modern vehicles offer the driver only a limited view of the car's surroundings. Ever smaller side and rear windows, combined with a vehicle shape that is strongly influenced by aerodynamics and pedestrian protection, is making safe and precise maneuvering more and more difficult, if not practically impossible. The Bosch reversing camera system helps drivers when reversing. A live camera image in the radio or navigation

system's display shows the area directly behind the vehicle. This "third eye" is automatically activated when reverse gear is engaged. The driver can see on the display in real time whether the way is clear. What the camera cannot do is show the area around the vehicle's corners or supply precise information on distance. For this reason, Bosch combines camera technology with ultrasound-based parking assistance. These technologies complement each other perfectly: for example, distances measured by the ultrasound sensors are displayed as colored bars in the live camera image. This means all relevant information is available to the driver at a glance.

Outlook: multi-camera systems and valet parking

Bosch is already working on multi-camera systems that are able to present drivers with a distortion-free, high-quality bird's-eye view of their car and its direct surroundings. In a next step, the video systems will not only be able to show the pictures they record, but also interpret them. Intelligent camera systems will analyze the video sequences. If they detect obstacles and moving objects in the vicinity of the car, they will warn the driver, or where there is an acute risk of collision, intervene – for example by braking quickly.

In the future, "valet parking" solutions will completely relieve drivers of the time-consuming search for parking spaces and the irksome tasks of parking and pulling out. The vehicle will receive information on any free parking spaces in a parking lot or garage at the start of the journey. The driver will then stop the car at the entrance and get out. After the function has been activated, the vehicle will drive itself to the designated parking space, and when requested by the driver, also drive itself back out to a designated pick-up spot.

Bosch ultrasound sensors: identical and cost-effective

For all these ultrasound-based functions, Bosch uses identical, cost-effective sensors. The Bosch scalable platform concept offers automakers maximum flexibility – systems solutions can be precisely tailored to individual vehicles. A highly integrated ASIC control unit enables functions to be easily integrated into a central control unit, or alternatively into a smaller, stand-alone control unit.

Bosch close-range camera: small and powerful

Bosch uses the latest CMOS (complementary metal oxide semiconductor) technology for its cameras, which delivers outstanding image quality even in high-contrast or low-light situations. To capture the largest possible area, Bosch uses cameras with a 180-degree angle of view. The inevitable

fish-eye distortion is corrected optically and/or by applying a powerful algorithm. The driver thus sees a natural and easy-to-comprehend representation of the car's immediate surroundings.

Bosch: 20 years of experience with parking functions

1989: Bosch begins developing ultrasound sensors for monitoring the parking space ahead of and behind vehicles.

1993: Ford Germany launches the first Bosch parking system on the market – as an optional feature for the Ford Scorpio.

1994: Mercedes-Benz installs the second generation of sensors in its S class.

1997: General Motors is the first U.S. automaker to order Bosch ultrasound sensors.

2006: Bosch develops the world's first parking assistant to measure the length of parking spaces. It debuts in the Citroen C4 Picasso.

2008: The first Bosch semi-automatic parking assistant for vehicles with electrical power steering debuts in the Mercedes A and B classes.

2010: The Bosch side-view assistant is the world's first ultrasound-based blind-spot recognition function, and expands the company's ultrasound-based product portfolio to include maneuver assistance functions.

2011: Bosch launches the second generation of its parking assistant. One feature it offers is improved parallel parking. The new pull-out assistant also steers the car backward and forward in the parking space until it can drive off safely in one maneuver. It offers a new perpendicular parking assistant as well, which can drive the vehicle into parking spaces at a right angle to the direction of travel.

More information online:

Driver assistance systems

Sensors for automotive electronics

Sensors for consumer electronics

Sensors – how technology maps the world around it

MEMS: the stars of the sensor world

Videos:

[Automatic parking assistant](#)

[Automatic parking assistant](#) (footage)

[Perpendicular parking assistant](#)

[Side view assistant](#)

Press photos: 1-AE-12654, 1-AE-14779, 1-AE-15642, 1-AE-15876,
1-AE-16424, 1-AE-17866, 1-AE-17867, 1-CC-18725, 1-CC-19219-e

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Perfect integration in the vehicle **mySPIN - smartphone integration from Bosch** Supports all the popular standards

September 2013

PI 8272 CM Si/af

- ▶ Automobile manufacturers can specify applications
- ▶ The apps are made automobile-compatible and controlled via the vehicle display

Use the navigation app to guide you by the fastest route to the next appointment taken from your personal calendar while at the same time listening to your favorite music on Internet radio and booking a suitable hotel room en route. The Car Multimedia experts at Bosch have developed mySPIN, a highly appealing smartphone integration solution that creates a perfect device-vehicle link and ensures safe and reliable in-car use. It allows users to continue using their preferred apps on their iPhone® or Android smartphone in the way they are accustomed to and without compromising safety.

Safe operation via the vehicle's display

The integration solution by Bosch SoftTec GmbH provides an almost identical design and user experience for both mobile operating systems. Once it has been downloaded onto the mobile phone, mySPIN creates a smartphone-vehicle link inside the car. The apps are then made automobile-compatible, that is to say, they are pared down to present the driver with only the relevant information. The apps are subsequently displayed and controlled via the vehicle display.

"The ability to integrate smartphones and all relevant apps in their vehicles means car manufacturers are not only in a position to offer their customers an attractive range of new services but also means that the link to customer smartphones opens up an additional direct marketing channel for them to selectively address their customers," explains Claus Ritzloff, head of sales at Bosch SoftTec GmbH.

What is more, automobile manufacturers can conveniently access the vehicle data via a web interface, thus enabling them to offer customers additional applications and services.

Huge variety of popular apps available anytime

This new system is fueled by apps, which are growing in number all the time. A wide variety of popular apps is already available for the mySPIN solution from Bosch. They include the most frequently used media player, maps, calendar and contacts apps. Also well-known applications like TomTom, Parkopedia, Winston, Hotelseeker, Glympse, Sticher and INRIX are ready to be used at any time.

All apps have been specially designed for use during the journey to be as least distracting as possible, thus ensuring maximum safety. There are only very few technical hurdles for applications to achieve this. App developers are provided with a software development kit.

The automobile manufacturer can specify which apps can be utilized in the vehicle by adding them to a white list. This white list can be updated and expanded as and when needed. The first vehicles of a European premium car manufacturer equipped with this globally applicable smartphone integration solution from Bosch will soon be on the road.

Press photo: 1-CM-19455

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Bosch SoftTec GmbH, which was first formed in July 2011, is headquartered in Hildesheim and is a subsidiary of Robert Bosch Car Multimedia GmbH. On the basis of decades of experience in the field of Car Infotainment and automotive software, a small team of specialists at Bosch SoftTec develops new product solutions in the segments for automotive software, connected services, cloud and smartphone applications.

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Increased safety and convenience while on the move **Mobility services from Bosch**

September 2013

PI 8295 ST Goe

- ▶ Connected mobility and service concepts for the automotive industry
- ▶ Car manufacturers rely on eCall service from Bosch
- ▶ Information, breakdown, and maintenance services increase convenience for drivers

Frankfurt am Main, Germany – International service provider Bosch Communication Center is increasing its range of mobile services for the automotive industry. Bosch offers its customers a comprehensive portfolio of connected driving services that includes new convenience and safety solutions.

Safety in mind

The eCall service from Bosch was successfully introduced in mid-2012. It is now available in 23 European countries and is already used in series-produced cars by several manufacturers. The vehicle uses the automatic emergency call service to send data about an accident, such as the location, time, and direction of travel, to the Bosch monitoring centers. The advantage of the Bosch solution is that, in addition to transmitting data, it establishes a voice link with the car involved in the crash and finds the nearest police and rescue service. The multilingual associates at the communication center speak to both the vehicle's occupants and the local authorities in their relevant languages. This system enables other important details on the nature of the accident or the persons involved to be passed on directly to the rescue services.

Personal assistant on board

In addition to the eCall emergency call service, Bosch is offering an expanded range of mobile services, with a particular focus on a mobile information service. The associates at the service center enable drivers to access a wealth of information even while on the road, including

information and booking options for hotels in the destination city, as well as suggested activities, the weather forecast, traffic alerts, and route planning information. The information can be requested from the service center by telephone or via SMS, so that drivers always have a personal assistant on board. Available in more than 30 languages, these global service concepts are based on Bosch Communication Center's international network of more than 20 locations in 13 countries around the world. It will also be possible to integrate technical partners or "content providers," meaning the range of information services available to customers can be further enhanced in the medium term.

Greater convenience while on the move

The range of mobile services also includes remote services, which provide vehicles with additional convenient features. At the driver's request, a Bosch associate can control certain functions via remote activation, depending on the respective vehicle architecture and the additional components available. For example, the vehicle can be unlocked remotely if the key has been locked inside it by mistake.

The new range of services also includes a breakdown and maintenance service. If a vehicle breaks down, associates at the service center can obtain and process all of the relevant details on the vehicle, allowing them to coordinate the pick-up and towing process with partner companies. Depending on the vehicle infrastructure, the maintenance service enables certain functions or maintenance cycles to be sent via an automatic signal to the monitoring center, which then coordinates the inspection procedure. The final mobile service is a tracking service, which can be activated in certain situations, such as if the vehicle is stolen. The range of services is available in a modular system, enabling Bosch customers to combine different services in different ways. An all-in-one solution is also available, which can include the service itself along with complex technical integration, and development and management of an international partner network.

Always on: connected mobility and service concepts

The new range of mobility services from Bosch Communication Center is part of the company's continued expansion into this area, and strengthens its position as an international provider of complex technical services for the automotive industry. "We take the technical expertise of one of the world's largest suppliers to the automotive industry and combine it with innovative mobility and service concepts," says Claudia Freundt, the head of automotive mobility services at Bosch Communication Center.

“To do this, we provide an international platform that uses highly specialized technical solutions to link vehicles with the personal service provided by our associates.” The additional services on offer enable automotive manufacturers to satisfy their customers' expectations in terms of the availability of information and networking in their vehicle, while also giving these manufacturers the opportunity to differentiate themselves more clearly from the competition.

Press photo: 1-ST-19471

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The Bosch division Security Systems is a leading global supplier of security, safety, and communications products, solutions and services. More than 12,100 associates generated sales of 1.5 billion euros in fiscal 2012. Protecting lives, buildings and assets is our aim. The product portfolio includes video surveillance, intrusion detection, fire detection and voice evacuation systems as well as access control and management systems. Professional audio and conference systems for communication of voice, sound and music complete the range. Bosch Security Systems develops and manufactures in its own plants across the world.

Additional information can be accessed at www.boschsecurity.com

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Additional information is available online at www.bosch.com and www.bosch-presse.com



Innovation on the windshield **Bosch Jet Wiper – new wiper-arm generation makes driving safer** Clear vision in every driving situation

September 2013
PI 8226 ED Hn/af

- ▶ Nozzle elements integrated into the wiper arm
- ▶ Windshield is cleaned effectively, regardless of speed
- ▶ Uses commercially available wiper blades

The new Bosch Jet Wiper brings innovation to the windshield. The nozzle elements, which are integrated into the wiper arm, spray the washer fluid onto the windshield directly to the front of the wiper blades. As a result, the windshield surface is evenly cleaned, and the spray mist does not compromise the driver's vision. "The Jet Wiper shows that Bosch can make further improvements to even such seemingly mature products as windshield wipers," says Udo Wolz, president of the Bosch Electrical Drives division.

Clear vision enhances safety

Conventional windshield cleaning systems are designed for a certain speed. As vehicles speed up, the airstream increases, and this diverts the stream of washer fluid. As a result, less fluid ends up in the area that needs to be washed, and the windshield is not cleaned as well as it should be. Via either one or two nozzle elements integrated in the wiper arm, the Jet Wiper ensures that just the right amount of washer fluid lands exactly where it is needed – namely, immediately to the front of the wiper blade's lip. Cleaning the windshield in this way reduces the amount of fluid required by up to 30 percent, and the tank has to be refilled less frequently. Alternatively, automakers can make the washer-fluid tank smaller, which saves valuable space and reduces vehicle weight. This, in turn, helps reduce CO₂ emissions.

Use of standard wiper blades and integrated heating

The Jet Wiper does not require special wiper blades, as it is compatible with commercially available ones. Changing the wiper blades is done in exactly the same way as before, with no extra effort or cost. What is more, the system can be heated: when outside temperatures drop below 5 degrees Celsius, a temperature sensor turns on a heater for the supply hoses and nozzles. This helps ensure that the cleaning nozzles operate reliably in winter conditions.

Bosch has consistently improved wiper technology

The wiper system success story began as early as 1926. At the time, Bosch was the first to bring a wiper system to market that operated at steady intervals and was powered by electric motors. Following a number of improvements over the years, the company introduced the twin wiper, which was the first wiper blade to feature a two-component synthetic rubber and integrated spring bars. The hard wiper lip ensured clear vision, and the soft back eased the reversing behavior of the rubber when the wiper changed direction. Launched in 1999, joint-free Aerotwin windshield wipers marked another milestone. The one-piece rubber profile with integrated spring bars and spoiler is quieter, especially at higher speeds, and ensures consistent washing performance. Today, these wipers are in widespread use across the automotive industry. Launched in 2001, the first electronically operated wiper system with two separate motors took up significantly less space. The same is true of the world's first direct drive for wiper systems in a mass-produced vehicle, which eliminates the need for rods under the hood. The technology has been in series production since 2011.

Press photo: 1-ED-19362

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Automotive Technology is the largest Bosch Group business sector. In 2012, its sales came to 31.1 billion euros, or 59 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. Its roughly 177,000 Automotive Technology associates worldwide mainly work in the following areas of business: injection technology for internal-combustion engines, alternative powertrain concepts, efficient and networked powertrain peripherals, systems for active and passive driving safety, assistance and comfort functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, and concepts, technology, and service for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP® anti-skid system, and common-rail diesel technology.

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Electronic horizon from Bosch

Predictive navigation data lower fuel consumption and emissions

Powerful networking of vehicle systems

September 2013

PI 8277 BEG Fi

- ▶ Innovative functions reduce fuel consumption by up to 15 percent
- ▶ Cross-systems networking of powertrain, driver assistance and braking systems with the electronic horizon
- ▶ Individualized solutions to suit brand-specific driving behavior and the features of different vehicle models

It is common knowledge that driving with foresight can significantly reduce fuel consumption. A system called the electronic horizon greatly extends the driver's range of view by creating a detailed preview of the road ahead based on enhanced digital map data, including topographical data such as the grade of inclines and the radius of bends, together with information derived from infrastructural features such as road signs indicating maximum speed limits. "By linking automotive systems with electronic horizon data, it is possible to reduce fuel consumption by up to 15 percent," says Bernhard Bihl, president of Bosch Engineering GmbH.

Data from the electronic horizon are already being used to provide driver assistance functions such as recommending gear changes, alerting drivers to upcoming bends, and automatically adapting the inclination of headlamps when entering a curve. In future, when the electronic horizon is linked to the navigation system, it will be possible to distribute these data to other control devices via the vehicle communication bus using the standard ADASIS v2 (Advanced Driver Assistance System Interface Specification) interface protocol. By logically linking such data with the ACC adaptive cruise control and engine management systems, it will be possible to implement new functions that reduce the driver's workload and cut fuel consumption.

ACC with “foresight”

The adaptive cruise control functions available today already simplify the driver’s task by regulating the speed to a preset value defined by the driver, and automatically maintaining a safe distance to the vehicle in front. Bosch intends to widen the scope of these functions by integrating electronic horizon data in the ACC. A control unit calculates the vehicle’s future velocity curve using the data from the electronic horizon, which provides information on the route ahead extending well beyond the next bend. It is not necessary for the navigation system’s route guidance function to be activated. If it is, the electronic horizon uses the route data calculated by the navigation system. If the route guidance function is not active, a control device repeatedly calculates the vehicle’s probable route. When the ACC function is activated, it now automatically regulates the vehicle’s speed, reducing it if necessary when approaching bends and road signs indicating speed restrictions or built-up areas, as well as when it detects obstacles or slow-moving vehicles ahead. This enhanced functionality means greater comfort and safety because it allows the driver to concentrate on steering the vehicle and observing the traffic.

Predictive engine management

In future, Bosch integrates data from the electronic horizon in the operating strategy and energy management functions of vehicles with internal combustion engines and hybrid or electric drives. The potential to improve efficiency by configuring the driving strategy on the basis of predictive data, thereby reducing fuel consumption by up to 15 percent, is particularly high in the case of hybrid vehicles. The engine management system can use the route preview to calculate how much energy the powertrain will need and control the dynamics of the internal combustion engine and/or electric motor according to the anticipated requirements.

“For instance, when the system identifies a segment of the route in which a hybrid vehicle will be able to recuperate more energy than it expends, it can engage the electric motor to discharge the battery before reaching this point,” explains Bihr. Different methods can be employed to reduce the vehicle’s speed depending on the operating strategy: using the engine brake, or recuperating more energy from the electric motor, or coasting. The operating strategy can be configured to different settings ranging from an eco mode that emphasizes fuel efficiency to a sport mode that emphasizes dynamic performance.

Press photos: 1-BEG-19458, 1-BEG-19459, 1-BEG-19460, 1-BEG-19461

Links for further information:

- Footage with narration networking with the electronic horizon:
http://videoportal.bosch-presse.de/clip/_/na/BEG/bosch-engineering-gmbh?category=motorpresse-kolloquium-2013
- Film footage networking with the electronic horizon:
http://videoportal.bosch-presse.de/clip/_/na/BEG/bosch-engineering-gmbh-7?category=motorpresse-kolloquium-2013

Contact for journalists: Annett Fischer, phone +49 7062 911-79137

Bosch Engineering GmbH is a wholly owned subsidiary of Robert Bosch GmbH and is headquartered in Abstatt, Germany. Since 1999, Bosch Engineering has been offering engineering services for automotive, industrial and marine applications, railway and commercial vehicles, off-highway applications, as well as powersports – independent of the actual production numbers needed.

More information is available online at www.bosch-engineering.com

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Integrated vehicle dynamics control **Networking of vehicle dynamics systems for more comfort, agility, and customization** First series application in SLS AMG Electric Drive

September 2013
PI 8278 BEG Fi

- ▶ New, patented integrated vehicle dynamics control function networks existing systems
- ▶ Enhanced comfort, agility and safety through networking
- ▶ A choice of different driving modes, plus the freedom to configure your own mode, permit a high level of customization

The automotive industry is working intensively on the integration of existing on-board electronic systems, the aim being to enhance driving safety, comfort and agility, and enable drivers to customize their vehicles' handling characteristics. Bosch Engineering GmbH has developed an integrated vehicle dynamics control that networks and manages existing on-board dynamics actuators in a completely new way. It enables drivers to adjust their vehicles' handling characteristics individually to match the driving situation – from a comfortable ride through to sporting fun. The function allows automakers to fine-tune a vehicle's handling characteristics to suit their own particular brand or model strategy. The first series-production vehicle to be equipped with the function is the SLS AMG Electric Drive, which has an electric motor on each of its four wheels.

System networking for enhanced vehicle dynamics control

The integrated vehicle dynamics control function networks and manages a car's existing vehicle dynamics actuators – such as brakes, rear-wheel steering, active front steering, active stabilizers and differentials. With hybrid and electric vehicles, it also interconnects wheel-specific electric motors. The patented function assigns each of these actuators particular handling characteristics, which it can influence to a large degree. Rear-wheel steering, for example, has a major impact on a vehicle's steering response and steering effort. By contrast, its balance and oversteer/

understeer characteristics can be altered, for example, through a combination of the brake system and the ESP® electronic stability program. The integrated vehicle dynamics control coordinates and steers a vehicle's actuators in a thoroughly innovative way to achieve the desired handling characteristics. From the driver's perspective, the vehicle's handling is natural and does not feel artificially controlled. Drivers can experience a car that is both comfortable and responsive to their driving preferences, without the necessity of altering the vehicle's hardware.

Driving modes that offer greater individuality

The integrated vehicle dynamics control can be used with a large number of different actuators and can be adapted to suit both manufacturer- and model-specific requirements. Bosch Engineering has implemented a version with three programmed settings or modes (Safe, Sport and Drift) along with a fourth, freely configurable, mode. In Safe Mode the emphasis is on greater comfort and safety, with the vehicle dynamics actuators set to respond less directly and ensure stability when driving on long straight stretches of road. Sport Mode is the opposite. Here, the focus is on achieving the highest levels of agility and dynamics. The integrated vehicle dynamics control sets the actuators for neutral balance and agile response. The Drift Mode guarantees maximum dynamics and fun on closed race tracks – something that holds particular appeal for manufacturers of cars produced in limited series. Finally, in Custom Mode the driver can freely configure the vehicle dynamics via three basic variables – stability, balance and agility. The desired configuration can be saved and reactivated again at any time.

Press photos: 1-BEG-19432, 1-BEG-19433

Links for further information:

- Footage with narration integrated vehicle dynamics control:
http://videoportal.bosch-presse.de/clip/_/na/BEG/bosch-engineering-gmbh-3?category=motorpresse-kolloquium-2013
- Film footage integrated vehicle dynamics control:
http://videoportal.bosch-presse.de/clip/_/na/BEG/bosch-engineering-gmbh-4?category=motorpresse-kolloquium-2013

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Solutions for private customers and businesses **Bosch offers dealers and companies easy access to electric mobility**

September 2013

PI 8279 AA Dr

- ▶ Complete package includes installation of equipment by trained personnel and offers a safe and convenient way to charge vehicles
- ▶ eMobility Starter Package back-end solution opens up possibility of new business models
- ▶ Open interfaces allow easy system connectivity

Berlin – Making it safe and easy to charge electric vehicles is a key factor for the success of electric mobility. Drivers have two options when it comes to charging their vehicles: They can use a charging station available in a public space and/or have a charging station installed in their own garage for personal use. With the charging stations from Bosch, both options are possible.

These devices, which have been approved by leading vehicle manufacturers, offer drivers a safe and convenient way to charge their vehicles in virtually any location. The charging stations for private customers can easily be fitted to a wall or mounted on a column outside. To ensure that customers do not encounter any problems during installation and commissioning, Bosch offers the systems as a complete solution. As part of this solution, Bosch advises customers on the options and arranges for the station to be connected to the mains safely and fitted to the wall.

Bosch currently offers a range of charging stations for different manufacturers. These stations can be configured in a number of ways to suit the customer's requirements – for instance, various plug systems are available in order to meet the different standards in place across Europe.

The components can also be installed in a public space, meaning that workshops or car dealers can use the charging columns to charge their own fleet and also make them available to their customers. Technologies

such as RFID cards can be installed in order to control access to the charging columns.

Bosch offers a software solution for networking these charging stations. This eMobility Starter Package allows companies to offer the use of the charging infrastructure to third parties and to charge for this usage. Not only does this system increase the utilization and cost-effectiveness of the available charging stations – it also increases the density of the supply network.

The software that controls and manages the charging infrastructure is offered as an online service (software as a service) – which means that customers do not need to invest money in their own IT systems to make use of the infrastructure.

The advantage of this solution is that companies, public institutions and public utility companies can operate their own charging infrastructure for electric vehicles, providing the means for these vehicles to be used on a daily basis. Charging points, customer and vehicle data and price plans are all managed using one integrated system, so these companies can provide their customers with easy access to services relating to charging their vehicles via online portals or using smartphone apps. This means that operators always know exactly how much the station is being used, while customers enjoy complete transparency with regard to charging times and can find the closest available charging station at any time using an app.

The new eMobility Starter Package uses two key open interface protocols to connect to charging infrastructure systems. These protocols allow customers to adopt the electric mobility business model quickly and conveniently, as well as take advantage of eRoaming platforms such as the one offered by Berliner Hubeject GmbH. eRoaming platforms enable drivers of electric vehicles to charge their vehicles at various charging stations throughout Europe – even if the station is not operated by their energy supplier. What's more, the software solution from Bosch Software Innovations allows charging stations from different manufacturers to be integrated quickly and cost-effectively.

Press photo: 1-AA-19469

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The Automotive Aftermarket division (AA) provides the aftermarket and repair shops worldwide with a complete range of diagnostic and repair shop equipment and a wide range of spare parts – from new and exchange parts to repair solutions – for passenger cars and commercial vehicles. Its product portfolio includes products made as Bosch original equipment, as well as aftermarket products and services developed and manufactured in-house. More than 17,000 associates in 150 countries, as well as a global logistics network, ensure that some 650,000 different spare parts reach customers quickly and on time. In its “Automotive Service Solutions” operations, AA supplies testing and repair-shop technology, diagnostic software, service training, and information services. In addition, the division is responsible for the “Bosch Service” repair-shop franchise, one of the world’s largest independent chains of repair-shops, with some 16,000 franchises. In addition, AA is responsible for more than 600 “AutoCrew” partners.

Additional information can be accessed at www.bosch-automotive.com. Bosch Software Innovations GmbH, the Bosch Group’s software and systems house, designs, develops, and operates innovative software and system solutions that help our customers around the world both in the traditional enterprise environment and in the Internet of Things and Services (IoT). We place particular focus in this field on the topics of mobility, energy and building, manufacturing, and financial services. Whether in its special, targeted BPM+ and IoT editions or as flexible standalone products, our software suite is the perfect foundation not only for projects relating to the Internet of Things and Services but also for projects in the fields of Business Process Management (BPM) and Business Rules Management (BRM).

With some 550 associates worldwide, Bosch Software Innovations has locations in Germany (Immenstaad, Waiblingen, and Berlin), Singapore, China (Shanghai), Australia (Melbourne), and the United States (Chicago, Palo Alto, and Vienna).

More information can be found at www.bosch-si.com

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German automobile club ADAC to collaborate with driver portal Drivelog Extensive range of automotive information available online

September 2013
PI 8280 AA Dr

- ▶ Integration of Drivelog services into ADAC web offering
- ▶ ADAC provides up-to-date information for Drivelog users
- ▶ Gradual rollout of new services and information all around the subject "Get to know your car"

Berlin/Munich – Drivelog is the first service portal to combine mobility services for both drivers and workshops. As part of its new partnership with German automobile club ADAC, both organizations will offer an extensive range of automotive information on their respective websites.

The ADAC website now provides Drivelog users with up-to-date information on topics such as manufacturer recalls. The second phase of the rollout process for this new partnership is set to kick-off in fall this year, and will allow the 18 million members of ADAC to access selected Drivelog driver portal services directly via the ADAC website. ADAC members will also be able to access attractive special offers on www.drivelog.de from the second phase onward.

"Our partnership with ADAC means that we can provide Drivelog users with additional helpful information and extend the range of mobility services we offer," explained Drivelog Managing Director Florian Bankoley on signing the partnership agreement in Munich. "In Drivelog, we have found a competent partner who can help us to extend the range of online services we offer our members," said ADAC Marketing Manager André Zarth, commenting on the new partnership.

The Drivelog online portal allows drivers to maintain a constant overview of all costs, key data and other information relating to their cars. The free

web service from Bosch subsidiary Mobility Media GmbH, Berlin, at www.drivelog.de provides drivers with access to a digital service log and a cost monitoring function. It can also provide details of the nearest car workshop or the cheapest gas station, as well as eCommerce offers from companies such as tire suppliers.

Press photos: 1-AA-19333, 1-AA-19334

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Overall solution with flexible building blocks **Bosch expands its Telematics Services for intelligent fleet management**

September 2013
PI 8281 INST/MKC

- ▶ Comprehensive solutions allow fleet operators to expand and improve their offering
- ▶ Active maintenance management and remote diagnostics in the event of breakdowns
- ▶ Trip analysis for each fleet vehicle and comparisons within fleets
- ▶ Bosch Software solution offers easy integration into existing business processes

Berlin – Many fleet operators are keen to increase transparency and gain a better overview of their fleets so that they can make the services they offer their customers even more attractive, or expand the range of services they provide. Services high on the list of priorities for fleet operators include fuel consumption analyses, the ability to locate a vehicle automatically via GPS and an electronic logbook with theft warning capability. Bosch now offers fleet operators an overall solution that can be individually tailored to suit each fleet operator's requirements. Bosch has a wealth of expertise that is not limited to any one manufacturer, so all the solution components are suitable for integration in almost every type of vehicle.

Journey and service data is read out via the interface for the On Board Diagnosis (OBD) system in the vehicle. This data is sent to the Bosch server, where it is processed and then sent to the fleet operators. One advantage of this process is that it enables operators to optimize servicing by actively directing the vehicles to their partner workshops.

Safety, cost-effective vehicle management and customer retention are key concerns in fleet management. With Bosch software solutions, the data acquired can be easily managed and integrated into existing business processes. This gives fleet operators a better overview of the status of

their vehicles, reduces their reliance on workshops and keeps their overall vehicle costs down permanently. Fleet operators can activate a vehicle's GPS system and evaluate the data acquired to generate usage statistics, as well as to identify when a vehicle has been stolen. If, for example, a vehicle is moved without the ignition being switched on, the system presumes that it has been stolen.

Risk management is another important aspect. The vehicle systems are, for example, able to recognize when an accident occurs and document what happened. If the system identifies an accident situation, the Bosch Communication Center is informed. This center is manned around the clock. The center associates alert the police and emergency services, while at the same time trying to contact the driver.

The software solution can be integrated easily and seamlessly into fleet operators' existing IT systems and business processes, enabling them to make efficient, cost-effective use of their fleets.

Bosch is currently the only provider of a complete telematics solution. This solution is based on many years of experience in all areas of the process chain – from installing the technology in the vehicle through to evaluating the data acquired on the computer. The data is retained by the provider and processed at the request of the fleet operator.

Press photo: 1-AA-19470

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Bosch Software Innovations GmbH, the Bosch Group's software and systems house, designs, develops, and operates innovative software and system solutions that help our

customers around the world both in the traditional enterprise environment and in the Internet of Things and Services (IoT). We place particular focus in this field on the topics of mobility, energy and building, manufacturing, and financial services. Whether in its special, targeted BPM+ and IoT editions or as flexible standalone products, our software suite is the perfect foundation not only for projects relating to the Internet of Things and Services but also for projects in the fields of Business Process Management (BPM) and Business Rules Management (BRM).

With some 550 associates worldwide, Bosch Software Innovations has locations in Germany (Immenstaad, Waiblingen, and Berlin), Singapore, China (Shanghai), Australia (Melbourne), and the United States (Chicago, Palo Alto, and Vienna).

More information can be found at www.bosch-si.com

The Bosch Group is a leading global supplier of technology and services. In fiscal 2012, its roughly 306,000 associates generated sales of 52.5 billion euros. Since the beginning of 2013, its operations have been divided into four business sectors: Automotive Technology, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 360 subsidiaries and regional companies in some 50 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. Bosch spent some 4.8 billion euros for research and development in 2012, and applied for nearly 4,800 patents worldwide. The Bosch Group's products and services are designed to fascinate, and to improve the quality of life by providing solutions which are both innovative and beneficial. In this way, the company offers technology worldwide that is "Invented for life."

Additional information is available online at www.bosch.com, www.bosch-press.com and <http://twitter.com/BoschPresse>



Bosch Automotive Tradition offers parts, knowledge, service and emotions to fans of historic cars

September 2013

PI 8282 AA Dr

Classic black battery reproduced in original design

- ▶ IAA 2013: Classic black battery showcased as new reproduction project
- ▶ Technical training range extended for fans of both retro and classic cars
- ▶ "partbob.com" online shop for spare parts and original repairs

Karlsruhe - Bosch Automotive Tradition, the classic division of Bosch Automotive Aftermarket, supports classic car fans with a wide range of spare parts and information, including a free online knowledge database and the "partbob.com" online shop, which helps customers source spare parts and services. In addition to organizing the "Bosch Boxberg Klassik" rally for classic vehicles, Bosch Automotive Tradition also participates in many trade fairs and events for classic cars, allowing the division to establish a direct relationship with fans of historic cars.

Reproducing the classic black battery

Bosch Automotive Tradition is showcasing the classic black battery as a new reproduction project. On the outside, the battery will feature the original design, but the inner workings will be modernized. The housing will be made from plastic instead of hard rubber, which will boost starting power by up to 70 percent and give the battery greater stability. These modifications will help the battery to conform to the more stringent safety requirements for modern vehicles. The battery will also be almost entirely recyclable. The black battery will initially be available in six-volt versions, with twelve volt versions set to follow. This project will see Bosch Automotive Tradition once more helping to reproduce historic vehicles.

Original in every way

Bosch Automotive Tradition has access to a range of over 58,000 spare parts from the global pool of Bosch plants and can therefore ensure a supply of original Bosch spare parts for historic cars. In addition, the acquisition of Koller & Schwemmer means that the mechanical gasoline injection pump is part of the Bosch range once again. Where stock levels do not cover higher demand for a particular part, Bosch Automotive Tradition investigates the feasibility of repair concepts or reproduction according to original specifications – an approach epitomized by the classic battery currently being showcased. Furthermore, appropriate long-term storage or continued production after completion of series production guarantees the continued availability of older spare parts. Information about the current range of reproduction parts and spare parts is available on the homepage www.automotive-tradition.com. Spare parts are available from wholesalers, Bosch service workshops, www.partbob.com or from the classic divisions of automotive manufacturers.

Extensive online knowledge database

Bosch Automotive Tradition is helping retro and classic car enthusiasts to locate suitable spare parts using an extensive online knowledge database. Over 50,000 documents are available to download free of charge under the menu option "Knowledge" at www.automotive-tradition.com. The documents can provide answers to questions such as which starter was originally installed in a car and in which cars a particular controller was used, as well as provide information on which alternative spare parts can be used. Fans of classic cars use this knowledge database extensively, with the result that the range of documents available is constantly being expanded.

Online shop for classic car spare parts range

The online shop partbob.com offers rare spare parts and discontinued items as well as the Bosch classic car range. Owners of retro and classic cars can also make use of the "1:1 REMAN" repair service via the online shop. This service is available exclusively via the shop and offers original repairs for a whole range of Bosch parts and components, such as K-Jetronic fuel distributors and warm-up regulators and D-Jetronic induction tube pressure sensors. Bosch Automotive Tradition guarantees the quality and range of the products and partners offered, and ensures rapid, problem-free order processing.

Bosch Automotive Tradition offers classic car training

Bosch Automotive Tradition offers a range of training sessions on older Bosch systems, giving those in attendance the opportunity to gain practical knowledge directly from the manufacturer. Owners of retro and classic cars who are also fans of technology, as well as vehicle workshop staff wishing to top up their knowledge, can take part in special training sessions on topics such as D, K/KE and L-Jetronic and Bosch ignition systems. Our range is continuously being expanded. Information and dates can be accessed at www.automotive-tradition.com. The seminars will be organized at Bosch service workshops bearing the "Classic Service" endorsement, which indicates that they have specialist knowledge of repairs to historic vehicles. These workshops belong to a network that currently comprises 55 Bosch partner companies throughout Germany, Austria and Switzerland. For a list of these partner companies, including contact details and opening hours, please go to www.automotive-tradition.com. Information covering all aspects of the classic car world is also available on the Bosch Classic Division Facebook page www.facebook.com/automotive.tradition. There is also a free newsletter, which is available via the homepage at www.automotive-tradition.com.

Press photos: 1-AA-19191, 1-AA-19467, 1-AA-19468

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The Automotive Aftermarket division (AA) provides the aftermarket and repair shops worldwide with a complete range of diagnostic and repair shop equipment and a wide range of spare parts – from new and exchange parts to repair solutions – for passenger cars and commercial vehicles. Its product portfolio includes products made as Bosch original equipment, as well as aftermarket products and services developed and manufactured in-house. More than 17,000 associates in 150 countries, as well as a global logistics network, ensure that some 650,000 different spare parts reach customers quickly and on time. In its “Automotive Service Solutions” operations, AA supplies testing and repair-shop technology, diagnostic software, service training, and information services. In addition, the division is responsible for the “Bosch Service” repair-shop franchise, one of the world’s largest independent chains of repair-shops, with some 16,000 franchises. In addition, AA is responsible for more than 600 “AutoCrew” partners.

Additional information can be accessed at www.bosch-automotive.com.

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PRESS RELEASE

New BMTS exhaust gas turbocharger for gasoline engines in series production at Volkswagen

Frankfurt, September 2013 – The first exhaust gas turbocharger developed by Bosch Mahle Turbo Systems (BMTS) for passenger car gasoline engines has been successfully launched in the market. The turbocharger is part of the new 1.2-liter four-cylinder TSI engine from Volkswagen—and thus in a typical downsizing engine that has a high production volume due its use in the modular transverse matrix in many brands within the Volkswagen Group.

With this order, the successful launch of the turbocharger with variable turbine geometry (VTG) from BMTS in one of the most important diesel engines of the Volkswagen Group, the 2.0 TDI, is followed by a high-volume engine in the segment of highly efficient gasoline engines.

The efficiency of conventional combustion engines will be crucial in determining energy consumption and thus CO₂ emissions in transportation well into the next decade. This means that more and more compact engines where high tech compensates for lower displacement and a reduced number of cylinders will permeate the market to a significant degree. Turbocharging is one of the key technologies of the modern combustion engine for reducing consumption and emissions values and thereby staying below the strict limits for fleet fuel efficiency. At the same time, it represents a critical technology to continue improving the performance and characteristic of the engine. Only with its contribution can engines with lower displacement or a reduced number of cylinders efficiently reach higher specific output levels while simultaneously meeting the elevated requirements for comfort and performance.

With the identical design, the turbocharger covers two engine applications and is used in both the 63 kW and 77 kW power level variants. In the 1.2-liter TSI engine, the exhaust manifold is integrated in the cylinder head; the turbocharger is thus flange-mounted directly on the cylinder head. The exhaust flow measures up to 950°C when it strikes the turbine wheel, which is

PRESS RELEASE

made of the heat-resistant material Inconel. A water-cooled bearing housing moreover ensures that the turbocharger continuously withstands the high stresses.

In addition to durability, the responsiveness of the turbocharger is of particular importance. Only if it can put to efficient use even the low exhaust volume flow at low speeds, can the engine get enough air to raise the torque at an early stage. This so-called low-end torque enables the engine operating points with lower consumption in the lower speed range to be used more frequently in actual operation and allows earlier shifting to the next gear. The average engine speed and consumption is thus reduced in actual driving operation. For example, for the 63 kW variant of the 1.2 TSI engine, the maximum torque of 160 Nm is available as low as at 1,400 rpm.

The good responsiveness of the new BMTS turbocharger for gasoline engines is determined partly by design solutions, such as low-friction floating bush bearings and the design of the turbine blade geometry, which yields particularly high efficiency. However, simulations in the early phases of development are also critical. In addition to efficiency and durability, other significant aspects are calculated and tested in advance, such as the acoustic behavior of the turbocharger.

Its precise function and highest quality level can be achieved only with high-precision, modern production. At its St. Michael/Austria location, BMTS has constructed new production facilities. Many innovations were introduced here to contribute to a new benchmark in terms of quality and technology. For example, the impeller is milled, thus considerably reducing the inherent imbalance. This effectively reduces pulsation noise from the turbocharger and produces a high level of comfort. Such precise manufacturing also forms the cornerstone for outstanding long-term quality.

The end-of-line test is a world first. At the end of the production line, production parameters and balancing values are verified via a fully automated process and the functional capabilities of each individual exhaust gas turbocharger are confirmed. All data is stored separately for each component. In case of tool failure in the production process, the reaction is immediate and the affected parts can be traced back and quarantined, which allows the reliable processing of complaints.

PRESS RELEASE

Caption: pThe first exhaust gas turbocharger developed by Bosch Mahle Turbo Systems for passenger car gasoline engines is employed in the new 1.2 L four-cylinder TSI engine from Volkswagen.

Press photo: 1-BMTS-19516

About BMTS

Bosch Mahle Turbo Systems is the joint venture of Bosch and MAHLE, with a strong understanding of the complete system for combustion engines and outstanding know-how in development and large-volume production of engine parts and components. Founded in 2008, the joint venture between Robert Bosch GmbH and MAHLE GmbH currently has 400 employees at the locations of Stuttgart and Blaichach in Germany, and St. Michael in Austria.

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PRESSEINFORMATION

PRESS INFORMATION

PT EPS IAA 2013 EN

September 2013

Electric Power Steering Facilitates Networked Driving

The usage of electric power steering for passenger cars, like the ZF Servolectric® developed by ZF Lenksysteme GmbH, provides not only consummate ride comfort and unrivaled precision, but also allows a host of assistance systems to be integrated and supported. These assistance systems help enhance driving safety and comfort. The way in which data is transferred to the steering system is crucial in terms of the interaction between these networked systems. These driving dynamics parameters must also be coordinated and prioritized in relation to the steering assistance required by the driver.

Electric power steering system advantages

The increasing uptake of electromechanical steering gears (electric power steering, EPS) in passenger cars goes hand in hand with enhanced safety, ride comfort, and driving precision. The usage of electric motors to provide power assistance enables, unlike hydraulic steering systems, the power assistance to be easily controlled not only depending on the driver's requirements but also

by overlaying additional torque. In the case of the electric power steering system, a sensor detects the driver's steering torque and forwards it to the electric motor via a control unit; the electric motor then transmits the power assistance to the steered wheels via the steering rack. A key advantage in this respect is that the power assistance torque can not only be calculated as a function of the steering torque on the steering wheel, but a host of additional state variables in the vehicle can be easily taken into account using software. With three different versions, the ZF Servolectric covers all vehicle classes from supermini cars to mid-size and full-size models as well as light commercial vehicles. Depending on the installation space, performance of the vehicle electric system, and required steering torque, the servo unit is mounted on the steering column, a second pinion, or in parallel to the steering rack.

Assistance systems: "Driver thinks - car steers"

In modern volume-production applications of electromechanical steering systems, a host of assistance functions are already linked to the steering or enabled in the first place through the EPS. Speed-sensitive power steering is one example of a driver assistance function that increases comfort as part of the enhanced steering functions. Another option for increasing comfort, which has already been implemented in volume-production vehicles, entails personalizing the parameters that are responsible for the steering feel, i.e. mapping a range of setup variants that facilitate, for instance, a sporty and a comfort-oriented driving style. The enhanced steering functions also include algorithms which are used to ensure directional stability. Thus a crosswind or an inclined road surface, for example, may produce torque on the steering wheel which can be offset using suitable algorithms. In conjunction with other systems, the use of electromechanical steering also supports new functions, such as automatic parking. Separate control units are used to measure potential parking

spaces and to calculate the trajectory. The driver still operates the accelerator and brake pedal, while the steering movements are performed automatically by the steering system. Lane departure warning systems as well as enhanced lane keeping functions developed on the basis of these systems are also available for volume-production models. These interventions now essentially occur via interfaces provided by the Servolectric; the interfaces are used by networked control units. In addition to the actual requirements placed on the functionality of the assistance functions, statutory provisions also result in additional requirements.

Other assistance functions are used to provide the driver with suitable steering recommendations in order to respond correctly in critical driving situations. These come into their own e.g. during oversteer or under μ -split braking. The electronic stability program (ESP) requests additional steering torque which provides the driver with suitable assistance. These interventions are limited so that the driver is able to correct the steering at all times.

Future visions

In addition to the assistance functions already available for volume-production models, numerous enhanced and new steering assistance functions are now under development. Many of the current assistance functions are based on information from other control units. If, however, these functions are integrated into the steering, the assistance systems can be substantially improved by integrating internal steering data as well. At present, for instance, a steering recommendation is issued on the basis of ESP signals. Functions are currently being developed which themselves optimally assess the driving situation directly on the steering control unit, thus facilitating or improving functions such as μ -split braking, oversteer/understeer compensation, crosswind compensation, or rollover prevention. In addition to optimizing

existing assistance systems, a host of new functions are under development. The evasive maneuver assistance function is an assistance system that would enhance safety. Based on camera and radar information coupled with conventional driving dynamics sensors, an evasive trajectory can be calculated in the case of an imminent collision, and assistance is also provided where the driver prompts a suitable response.

Enhanced lane assist functions are also being developed. Based on information from camera systems, the time before the vehicle leaves the lane can be calculated in the steering using information such as lane camber, distance to the lane markings, and position in the lane, and a tiered warning concept can be implemented accordingly. The driver is suitably alerted to correct his steering intervention by applying additional torque to the steering system. Similarly, a collision warning can also be implemented using additional information on objects in the blind spot.

Another area of development involves enhancing current lane assist functions to include information from navigation systems. This information extends the anticipation horizon by including information on radii of curvature outside the camera's range, data on speed limits, or lane constrictions to specify further lane assistance.

The steering is increasingly being networked. Complex assistance systems require suitable strategies to coordinate and prioritize the individual requirements. ZF Lenksysteme has developed a "FunctionCoordinator" to this end, which coordinates and prioritizes the various target values on several levels. It has to meet the most stringent safety requirements. The "FunctionCoordinator" links disparate assistance functions, networked or internally, while complying with all safety,

coordination, and prioritization requirements. The individual requirements are managed and controlled centrally, thus allowing functions to be added easily and all requirements managed safely.

Caption:

Economical and compatible with other systems: The Servoelectric electric power steering system from ZF Lenksysteme.

Press photo: ZF Lenksysteme GmbH - 1-ZFLS-18554

ZF Lenksysteme GmbH, a 50:50 joint venture of Robert Bosch GmbH and ZF Friedrichshafen AG, is a specialist and technological leader for steering technology. The company employs a workforce of over 12 700 at 17 locations in eight countries. In 2012, it achieved a sales figure of more than EUR 3.98 billion.

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PRESSEINFORMATION

PRESS INFORMATION

PT Trailer en IAA 2013

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Smart Trailer Parking – Reversing with trailer via smartphone

For safe, easy, and comfortable reversing of car/trailer combinations, ZF Lenksysteme GmbH has developed a reversing assistant.

- **Easy steering of the vehicle with its trailer via smartphone/tablet**
- **Control of bending angle and speed**
- **No blind spot thanks to remote control of the car/trailer combination from outside**

Core components of the system are the Servolectric® electric power steering by ZF Lenksysteme (ZFLS) and a trailer coupling with bending angle sensor by ZF Friedrichshafen AG. The assistant is controlled via a smartphone app developed by ZFLS which sets the angle and speed. In addition to an automatic transmission, an electric power steering system is required for changing the driving direction.

Most drivers are overchallenged by maneuvering with a trailer. The steering maneuvers that the driver has to perform when reversing with a car/trailer combination contradict the experience gained during driving without a trailer. An incorrect

steering motion causes the trailer to buckle too strongly or into the wrong direction. Furthermore, the trailer restricts the view to the rear causing a blind spot. Reversing with a trailer is thus posing a challenge even to experienced drivers.

Comfortable and safe remote control of the car/trailer combination via smartphone app

In order to also enable inexperienced drivers to reverse with a trailer and to reduce the accident risk and the stress level of the people involved, ZF Lenksysteme has developed this function. The driver maneuvers the vehicle with its trailer from outside by a self-developed app using a smartphone or tablet computer. The driver can position himself so that he has an optimum overview of the trailer, drawing vehicle, and the environment. The blind spot is eliminated, a banksman is therefore no longer required.

Before starting to drive, the desired direction of travel and speed can be set via the app. Then, the driver adjusts the display according to the real car/trailer combination for better orientation. If the user touches the virtual trailer on the display, the vehicle with its trailer is set in motion at the preset speed. By moving the trailer on the touch screen, the driver can determine the bending angle and thus the desired direction of travel of the car/trailer unit. If the driver moves the finger away from the touch screen, the unit stops immediately. When driving forward, the user moves the vehicle instead of the trailer. The bending angle is adjusted via a special algorithm by the electric power steering system (EPS) while driving. In addition, the system prevents the trailer from excessive bending and therefore ensures maneuvering ability and avoids collisions between the drawing vehicle and the trailer.

While the driver has to deal with the complicated handling of the steering wheel and the pedals and follow the instructions given by the banksman when maneuvering without an assistant, only the bending angle has to be set for assistant-controlled maneuvering. This way, both filtering into a loading bay and parking with the trailer can be managed more fluently and in one step. Even drivers who have never driven with a trailer are able to safely maneuver it using Smart Trailer Parking within just a few minutes. But, in test operation, experienced drivers of car/trailer combinations also reacted positively to the increase in comfort and safety. Smart Trailer Parking uses exclusively technology that is already installed in every modern mid-size car with automatic transmission today.

Caption: Innovative and networked: Smart Trailer Parking by ZF Lenksysteme allows safe and easy reversing of car/trailer combinations. Easy steering via smartphone or tablet.

Press photo: ZF Lenksysteme GmbH – 1-ZFLS-19442

ZF Lenksysteme GmbH, a 50:50 joint venture of Robert Bosch GmbH and ZF Friedrichshafen AG, is a specialist and technological leader in the field of steering equipment and has a workforce of around 12,700 at 17 locations in eight countries. The Group generated revenues of 3.98 billion euros in 2012.

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