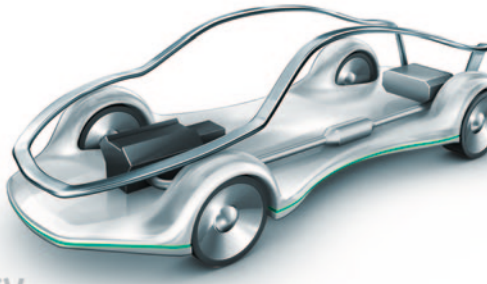
SCHAEFFLER

Efficient Future Mobility

eSolutions
eMobility
Light Weight
Low Friction
advanced Drive
Fuel Economy
Eco-friendly
CO_2 Reduction
creative technology
innovative systems
Hybrid Technologies
Energy Efficiency



IAA

Press Kit 2011

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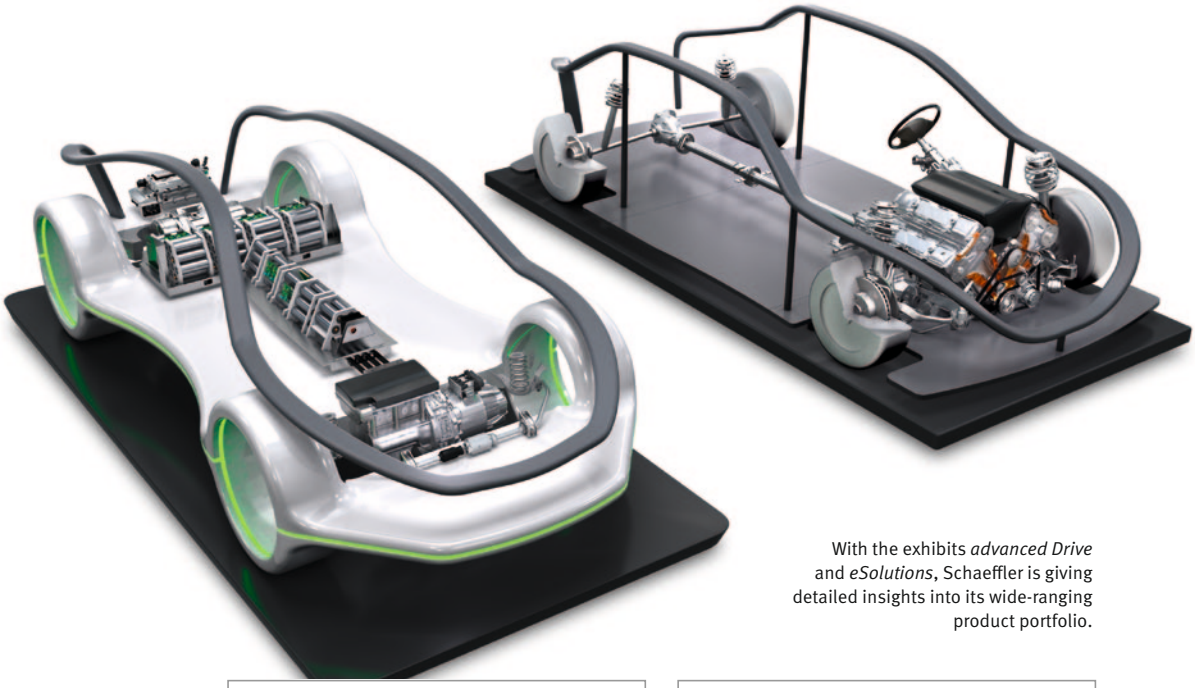
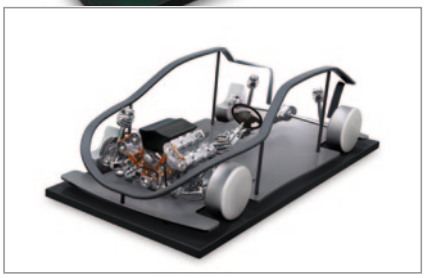
LuK INA FAG



With the exhibits *advanced Drive* and *eSolutions*, Schaeffler is giving detailed insights into its wide-ranging product portfolio.



About Schaeffler

With its brands INA, LuK and FAG, Schaeffler is a renowned supplier to the automotive industry as well as a leading manufacturer of rolling bearings worldwide. Sales of around €9.5 billion were generated at over 180 locations in more than 50 countries in 2010. With more than 70,000 employees worldwide, Schaeffler is one of the largest German and European industrial companies in family ownership.

Our main customer is the automotive industry with around 60 percent of our sales. Schaeffler is a renowned development partner to the industry with system expertise for the entire drive train. Precision products for engines, transmissions and chassis applications ensure reduced energy consumption and lower emissions as well as increased driving comfort and safety.

Content

Schaeffler presents wide portfolio of products at this year's IAA trade show ranging from efficient drive trains with internal combustion engines and hybrid solutions up to products for electric mobility

Versatile expertise for efficient mobility

- Mobility of the future will be driven by electric mobility and optimized internal combustion engines in equal measure
- Schaeffler creates solid foundation for electric mobility with its *eMobility Systems Division* and creates new jobs
- Schaeffler envisages potential for optimization in internal combustion engines of up to 30 percent
- Schaeffler makes decisive contributions to reducing fuel consumption and harmful substance emissions
- Schaeffler gains more than proportional benefit from the enduring trend in energy efficiency on its path of continuing growth

HERZOGENAURACH, September 13, 2011. Schaeffler is presenting two concept studies at this year's IAA with the motto *efficient future mobility*. The two exhibits, called *advanced Drive* and *eSolutions*, provide a detailed insight into Schaeffler's extremely varied product range for energy-efficient and forward-looking mobility.

Based on the diversification strategy used by supplier to the mobility industry Schaeffler, these components for increasing efficiency cover a wide-ranging spectrum of modern automobility. This is because Schaeffler offers innovative solutions for optimizing the drive train based on combustion engines as well as key components for hybrid vehicles and advanced solutions for electric vehicles.

Accordingly, the *eSolutions* demonstration vehicle contains a large number of Schaeffler products that are relevant to the issue of electric mobility. These products include components that are suitable for use in hybrid and electric vehicles. "Electric mobility will make a significant contribution to driving our business", says Prof. Peter Gutzmer, Chief Technology Officer at Schaeffler. "Over 50% of all automobiles will have an electric drive in 2020. In addition, *pedelecs* (bicycles with electric power assistance), electric scooters and commercial vehicles with electric drives, widen the scope of electric mobility." Wheel hub drives such as Schaeffler's *eWheel Drive*, facilitate new vehicle architectures. The key parameters important for conventional drive trains with internal combustion engines are increasingly becoming significant for electric mobility. These include driving dynamics and safety as well as driving

pleasure and reducing mass. The *eDifferential* from Schaeffler is a good example in this respect, since it enables so-called torque vectoring, which involves selective distribution of the drive torque thereby providing unique driving dynamics in electric vehicles.

In order to dedicate the appropriate attention to electric mobility, Schaeffler has now combined its activities in an *eMobility Systems Division*. The division has initially employed 300 people who are working solely in electric mobility on an international scale. In addition to the product range for electric and hybrid vehicles, at Schaeffler, the issue of electric mobility also involves considerations for the infrastructure associated with it. After all, the company has been one of the key suppliers to the wind power sector and other areas in renewable energy from the very beginning.

“In 2020 however, over 90% of vehicles will still have an internal combustion engine”, says Prof. Peter Pleus, President of Schaeffler Group Automotive. “In most of these automobiles, internal combustion engines will continue to serve as the single or primary drive source or they will serve as range extenders. These internal combustion engines still have a great deal of room for improvement in terms of fuel consumption – up to 30% in practice.”

When considering these improvements in detail, this potential can be achieved by optimizing the thermodynamics, minimizing pump losses and frictional resistance, using ancillary equipment controlled according to requirements, targeted thermal management, downspeeding, downsizing and the start-stop function. “The micro hybrid, that is the start-stop function, will feature in automobiles across the board in a very short time”, says Prof. Pleus. “This system makes special demands of various components and we are prepared for these demands.” Schaeffler’s concept study called *advanced Drive* demonstrates this system and other products for the efficient drive of today and the future.

“The requirements that efficient and forward-looking mobility place on suppliers to the automobile industry involve increasing levels of complexity in components, modules and systems”, explains Prof. Peter Gutzmer. “The continuing requirements in terms of energy efficiency mean that the focus is on reducing weight, optimizing friction and the increasing wide-ranging variability in the valve train.”

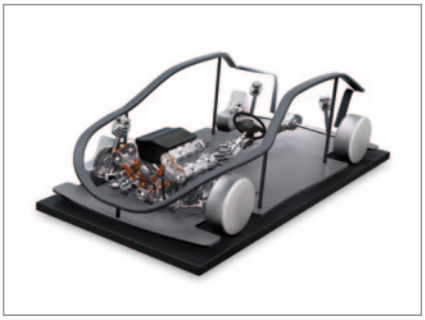
Energy efficiency is deeply-rooted in the DNA of Schaeffler. Optimizing frictional resistance is the primary purpose of a rolling bearing. Reducing fuel consumption and emissions is the primary motivation of valve train components, which Schaeffler has been manufacturing for decades.

The company's product range has long incorporated a wide variety of components, modules and systems that can significantly improve the fuel consumption and emissions of modern automobiles. This includes double-clutch solutions, dual mass flywheels and torque converters with centrifugal pendulum-type absorbers, electromechanical actuators, numerous solutions for variable valve trains, belt drives with optimized friction characteristics and other solutions for engines, transmissions and chassis. Sustained research and development activities in our global network of Schaeffler development centers enable the product range to grow on a continuous basis.

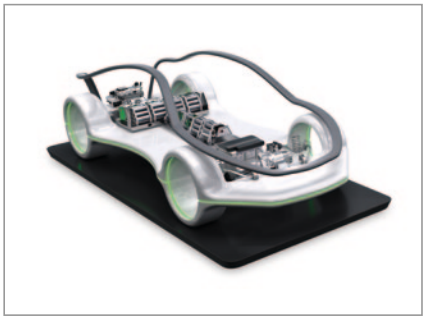
"With its *efficient future mobility* motto, Schaeffler continues to consistently pursue the path it has always traditionally taken", says Dr. Juergen M. Geissinger, President and CEO of Schaeffler.

"Schaeffler is in an excellent position in this respect. Activities such as setting up the *eMobility Systems Division* enable us to further develop our capacities in research and development as well as in manufacturing and allow us to orient ourselves towards the demands placed on us by the automobile of today and tomorrow. With a view to our innovative product range and the demands of global energy-efficient mobility, Schaeffler will gain more than proportional benefit from the growth in worldwide automobile manufacturing. Schaeffler is a global supplier of expertise for *efficient future mobility*."

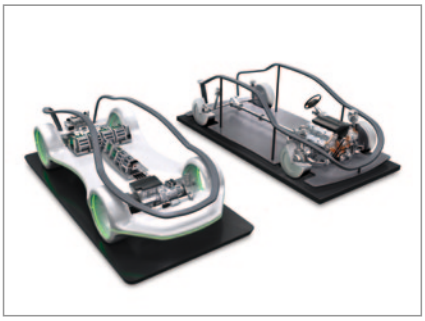
Images/Captions Efficient future mobility



advanced Drive shows a large number of Schaeffler products for drive trains based on internal combustion engines.



The concept study *eSolutions* reflects a series of Schaeffler solutions in the field of e-mobility.



With the exhibits *advanced Drive* and *eSolutions*, Schaeffler is giving detailed insights into its wide-ranging product portfolio.

Schaeffler demonstrates diversification strategy with *CO_2ncept-10*, *Schaeffler Hybrid* and *ACTIVeDRIVE* concept vehicles

Schaeffler presents diversity in automobility

HERZOGENAURACH, September 13, 2011. The challenges faced by automobility today span from optimizing automobiles with classic drive trains and internal combustion engines via numerous hybrid solutions right up to electric mobility. Schaeffler's concept vehicles *CO_2ncept-10%*, *Schaeffler Hybrid* and *ACTIVeDRIVE* show the company's diverse approach to modern automobility and provide an insight into Schaeffler's extremely wide product range.

CO_2ncept-10% is a vehicle that presents a range of optimization options in vehicles with internal combustion engines that can be implemented in a short space of time. The *Schaeffler Hybrid* presents various hybrid solutions and compares various operating modes. The *ACTIVeDRIVE*, is an all-electric vehicle (BEV or battery electric vehicle). "Furthermore, all three of these 'cars full of ideas' function as test platforms for realistic testing of various components and systems", says Prof. Peter Gutzmer, Chief Technical Officer at Schaeffler.

ACTIVeDRIVE – an innovative and dynamic electric vehicle

The main innovation of Schaeffler's *ACTIVeDRIVE*, which is based on a Škoda Octavia Scout, is the active electric differential (*eDifferential*) mounted on the front and rear axle. This component combines an electric drive with the option of controlling the drive power in each wheel individually. This facilitates torque vectoring (distribution of torque between the right and left wheels), which is beneficial for driving dynamics, safety and comfort. "The *eDifferential* permits intervention in driving dynamics through selective power supply instead of through braking intervention and thus power reduction as is the case with ESP. The active electric differential significantly improves the transmission of force when driving on surfaces with varying frictional values. It also supports the steering system and has a positive effect on the driving dynamics, safety and driving comfort. In addition, using two *eDifferential*s enables the longitudinal distribution of drive torques", says Prof. Gutzmer. Actively distributing the drive torque in both the transverse and longitudinal directions makes the *eDifferential* an ideal platform for innovative driving dynamics control. The solution demonstrated in the *ACTIVeDRIVE* makes Schaeffler a pioneer of such electric concepts in one vehicle drive. "Accordingly, the potential range of applications for the *eDifferential* spans from extremely-dynamic sports cars and vehicles in conventional

automobile categories right up to agricultural machinery", explains Dr. Tomas Smetana, Head of Advance Development in Transmissions Systems at Schaeffler Automotive.

The *eDifferential* integrates two water-cooled permanent magnet synchronous motors (PMSM) of different dimensions, a planetary gear, a transmission for active torque distribution and, as a key element, a Schaeffler lightweight differential. The electric drives are manufactured by Schaeffler brand IDAM. The larger up to 105 kW and 170 Nm PMSM provides the drive. The second PMSM, which regulates the distribution of torque, must only supply 5 kW of power in order to generate a difference in torque on the axle of up to 2000 Nm. The other innovations incorporated in the *ACTIVeDRIVE* are an integrated electromechanical parking lock, a new force-feed lubrication system without an oil pump for the transmission, planet carriers of sheet metal and various high-speed bearing solutions with optimized friction characteristics. The electronic control system is manufactured by AFT and is therefore also a Schaeffler product.

Due to the use of two active electric differentials, the concept vehicle has an overall output of up to 210 kW and features four-wheel drive. Li-ion batteries located in the propshaft tunnel and in front of the rear axle with a capacity of 18 kWh function as energy stores. Thanks to its performance and traction capacity, the test platform, which weighs 1,900 kilograms, accelerates from 0 to 100 km/h in 8.5 seconds. The vehicle features electronic top speed regulation at 150 km/h. The vehicle's range in this configuration is up to 100 kilometers.

Schaeffler Hybrid – presenting a wide range of hybrid solutions

The *Schaeffler Hybrid* is an advance development project – a 'car full of ideas' that facilitates a practical comparison of the various options available in electric mobility. It demonstrates various vehicle configurations and driving conditions. This means the *Schaeffler Hybrid* not only has a volume-produced combustion engine from a basic vehicle, but also has a central electric motor and two wheel hub motors.

"Presenting various concepts with informative comparisons as well as realistic testing played a decisive role in the implementation of the *Schaeffler Hybrid*", says Prof. Peter Gutzmer, Member of the Executive Management Board responsible for technical development at Schaeffler. Accordingly, the various elements can each be switched on and off and incorporate a wide range of various driving conditions. These options range from classic operation using a combustion engine, operation as a parallel hybrid or serial hybrid to operation using the electric motor only.

The combustion engine can power the vehicle and be coupled for use as a range extender. An automated manual transmission increases the options available. The transmission naturally incorporates clutch products specially matched to the requirements of hybrid vehicles from the Schaeffler brand LuK. The energy store, which is a 16 kWh lithium-ion battery (400 V, 400 A), is charged by means of energy recovery, the range extender as well as via an external power supply (plug-in hybrid). "Another important aspect of this advance development project are the networked development activities of the Schaeffler brands", says Prof. Peter Gutzmer. Specifically, these are INA, LuK, FAG as well as IDAM and AFT.

The central unit is flange located to the automated manual transmission by means of a toothed chain and drives the front wheels. The unit comprises a liquid-cooled 50 kW and 95 Nm electric motor that was designed and manufactured by Schaeffler subsidiary IDAM. *eWheel Drive* is the name that has been given to the wheel hub motors developed by Schaeffler. The second-generation motors mounted in the *Schaeffler Hybrid* have an output of around 70 kW each and torque of around 700 Nm. Schaeffler profits from its profound expertise in the field of wheel bearings and direct drive technology during the design and manufacture of these high-performance components. Accordingly, these wheel hub motors form a compact unit that integrates wheel bearing, drive and brake. The advantage of these drive units is the fact that they can be integrated in an existing vehicle platform without making any major changes to the vehicle architecture. In addition, the *eWheel Drive* from Schaeffler is already making a convincing case due to its appealing torque development as well as a remarkably low noise level.

"The *"Schaeffler Hybrid"* will not go into volume production", says Prof. Peter Gutzmer, "rather it serves as a vehicle of ideas. For example, with the *'CO_2ncept-10%'* based on a Porsche Cayenne, we have successfully demonstrated advantages in fuel consumption and emissions by reducing friction in the drive train. With the *Schaeffler Hybrid*, we want to demonstrate that Schaeffler takes a holistic approach to mobility and that it is giving serious consideration to innovative products for e-mobility solutions."

Along with the components shown in the *Schaeffler Hybrid*, Schaeffler's range of products tailored to the requirements of hybrid vehicles and electric mobility includes, amongst others, hybrid clutches (as used in high-end hybrid SUVs), electromechanical chassis and steering components, as well as various differentials. These differentials include the space-saving lightweight differential and the *eDifferential* in the *ACTIVeDRIVE*.

CO_2ncept-10% demonstrates potential for optimization in drive trains with internal combustion engines

The *CO_2ncept-10%* vehicle is a joint advance development project implemented by Porsche and Schaeffler that has achieved a total reduction in fuel consumption and CO_2 emissions of 10 % by using new and optimized components. The concept was first presented at the end of 2009 during the "Friction Reduction in the Powertrain" congress, which was supported by Schaeffler.

The *CO_2ncept-10%* is a CO_2 demonstration vehicle based on a Porsche Cayenne with a V8 engine. Various new and optimized proven components from Schaeffler's product range are used in this vehicle in the drive train and chassis that significantly reduce the fuel consumption compared with a volume-produced vehicle. Schaeffler was responsible for designing and verifying the individual components in this joint advance development project. Porsche was in charge of system coordination and validation for the entire vehicle. All in all, the concept vehicle generates savings of ten percent in fuel consumption. This has been proven not only in theory (using complex simulation calculations) but also in practice by Porsche during sophisticated test stand runs. The calculations were based on the standardized NEDC (New European Driving Cycle).

The engine is responsible for 5.8% of the reduction in fuel consumption and the CO_2 emissions associated with this. The main proportion of this – 4.1% – was implemented by modifying the VarioCam Plus valve control system by replacing the hydraulic camshaft phasing unit with an electromechanical system and by using optimized switchable tappets on the inlet side. An additional 1.7% was realized by the minimized frictional power by optimizing the components in the valve, belt and chain drive systems.

A further 1.1% reduction in fuel consumption is achieved by using double row angular contact ball bearings in the front and rear differentials. These so-called TwinTandem bearings replace the tapered roller bearings previously used and significantly reduce the frictional resistance compared with conventional volume-produced transmissions by 35% on the front axle final drive unit and by 42% on the rear axle final drive unit.

Savings in fuel consumption can also be made in the chassis, since a cut of 3.2% can be generated by replacing the hydraulic roll stabilizer with an electromechanical unit and by using smooth-running wheel bearings. "As is the case with camshaft phasing units, components actuated electrically make a significant contribution

in that they only require energy when they are actually used", explains Dr. Robert Plank, Head of Corporate Engineering at Schaeffler. "The pumps in hydraulic systems, on the other hand, must always provide hydraulic pressure and therefore require greater amounts of energy."

"This project is a good example of the successful cooperation between automobile manufacturers and suppliers. Networking in this way reduces development times, prevents costly redundancies and makes an important contribution to competitiveness", says Dr. Robert Plank. "*CO_2ncept-10%* is impressive proof of additional potential for optimization in a system close to volume-production standards. However, this is not the end of the line. *CO_2ncept-10%* is the sum of the individual components. And these are only some of the components that are part of Schaeffler's product range that enable comparable optimizations to be made in terms of energy efficiency in other vehicles."

Images/Captions *CO_2ncept-10%*, *Schaeffler Hybrid* and *ACTIVEeDRIVE*

The Schaeffler concept vehicles *CO_2ncept-10%*, *Schaeffler Hybrid* and *ACTIVeDRIVE* show the wide-ranging spectrum of modern automotive engineering and give a perspective on the extensive Schaeffler product portfolio.

With the *CO_2ncept-10%*, Schaeffler gives an overview of detailed solutions that are close to production status, which clearly show the striking potential for optimization in drive trains based on the internal combustion engine.

The *Schaeffler Hybrid* is a ideas concept allowing an illustrative comparison of various hybrid configurations. These include the Schaeffler in-hub motors known as the *eWheel Drive*.

ACTIVeDRIVE is an electric vehicle featuring the innovative *eDifferential* on both axles.

Schaeffler to bundle its electric mobility expertise in the *eMobility Systems Division* and create new jobs

Schaeffler Pursues Holistic Approach with Regard to Electric Mobility

HERZOGENAURACH, 13 September 2011. Schaeffler is bundling its numerous activities relating to electric mobility in an *eMobility Systems Division*. Schaeffler is thereby pursuing a holistic approach that integrates the expertise of both the Automotive and Industrial divisions. "Electric mobility is generating sustained and growing interest. As a development partner and supplier, we must react to this development", says Rolf Najork, Development Director of Transmission Systems and Electric Drives at Schaeffler. Accordingly, Schaeffler is creating an *eMobility Systems Division* for the purpose of combining the numerous individual competencies and developing the market at systems level.

"Suppliers play an active role in the development of electric mobility. With innovations and future-oriented products, they make an important contribution to progress and securing the future, which are always associated with considerable investments", says Prof. Peter Gutzmer, Member of the Board of Management and Chief Technology Officer at Schaeffler. "With the *eMobility Systems Division*, we are also creating structures at an international level that will enable us to cover this important field in its entirety."

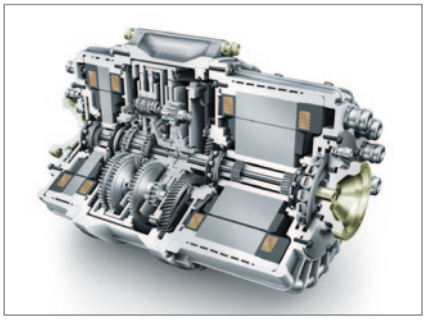
The *eMobility Systems Division* will initially provide jobs for 300 employees. Development capacities at Schaeffler's locations in Herzogenaurach, Bühl and Suhl will be expanded accordingly. Activities relating to electric mobility will also be increased at Schaeffler's development locations in China and North America. Schaeffler is searching for engineers with qualifications in technical subjects, natural scientists and industrial engineers.

"Schaeffler offers excellent opportunities for starting and developing a career in an international environment and in an important market segment that is at the cutting edge of technology. Our product range includes key components for the entire electric drive train and solutions for drives in hybrid vehicles and electric cars. Mechatronics is playing an increasingly significant role", says Rolf Najork. "Our innovations are used in both automotive and industrial environments."

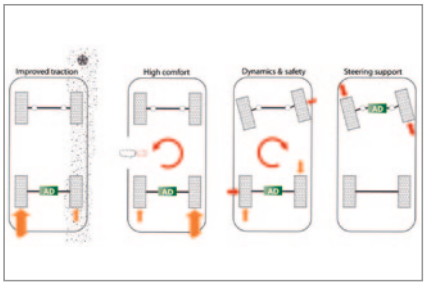
The product range already includes numerous solutions relating to electric mobility. The range extends from sensor bottom brackets for so-called *pedelecs*, start-stop solutions and hybrid clutches right up to electric drives. Schaeffler has made a name for itself, for example, with the hybrid solutions presented in the “car full of ideas”, the ”*Schaeffler Hybrid*, and the wheel hub drive *eWheel Drive*, as well as the *eDifferential* presented in the concept vehicle *ACTIVeDRIVE*. The product range is rounded out by special bearing solutions in the renewable energy sector.

Images/Captions Electric mobility

With *ACTIVeDRIVE*, Schaeffler is showing a concept study of an electric vehicle with strong driving dynamics.



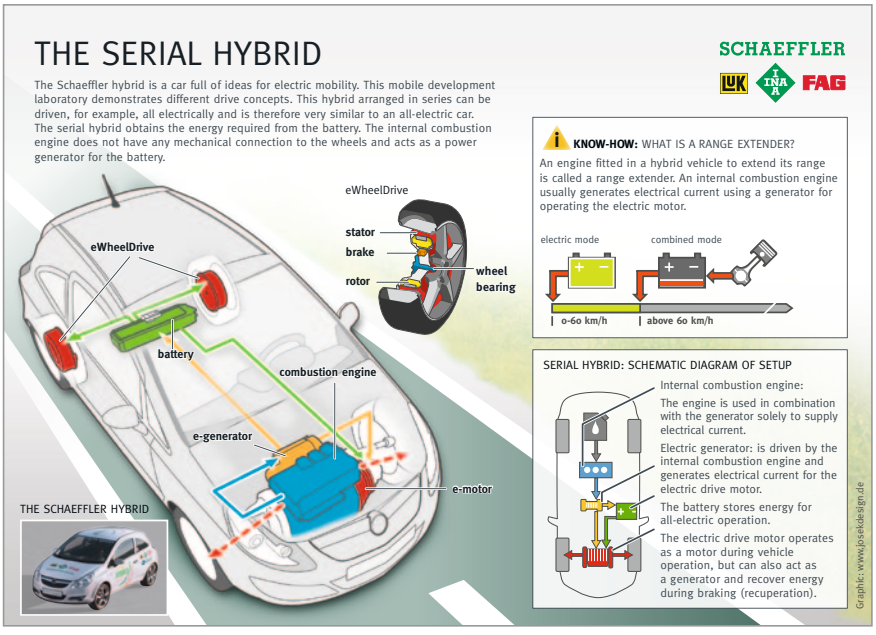
The heart of the *ACTIVeDRIVE* is the *eDifferential*. This is an active electric differential. It provides drive power for the vehicle as well as allowing power distribution between the wheels on an axle.



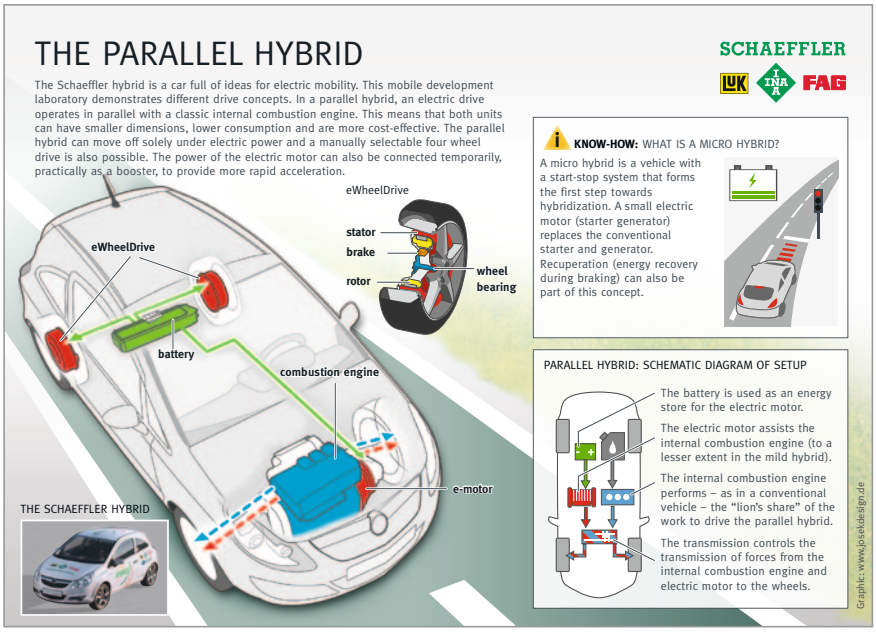
The *eDifferential* supports the steering function and has a positive effect on driving dynamics, safety and driving comfort.

Images/Captions Electric mobility

In the *Schaeffler Hybrid*, Schaeffler presents the innovative in-hub motor *eWheel Drive*. It also allows the development of completely new vehicle architectures.



The spectrum of Schaeffler components for e-mobility also includes sensor bottom bracket bearings.



Schaeffler Thermal Management Module Optimizes not only the Temperatures of Engines and Transmissions but also Hybrid Components and Batteries

Innovative thermal management module improves CO_2 footprint

HERZOGENAURACH, 13. September 2011. Schaeffler is helping to unlock new potential through the optimization of internal combustion engines with the new thermal management module. This innovative module is the key to reducing fuel consumption and CO_2 emissions by up to four percent.

The thermal management module is a temperature control unit for the entire drive train. It is integrated in a compact component manufactured from high-strength plastic and combines numerous functions. Where as engine temperature has been controlled until now in a rudimentary manner by a thermostat located close to the engine, the new modern thermal management module controls the temperature conditions in the vehicle precisely and enables operation in the optimal temperature window in the fastest possible time. This means on the one hand that the cold running phase is significantly reduced by completely blocking off the cooling jacket. On the other hand, the individual components can be operated at higher temperatures than would be possible with a system controlled by a thermostat. The engine temperature can also be reduced under full load and the tendency for knocking and enrichment of the mixture under full load can be reduced.

The opportunities for precisely controlling temperature in order to increase efficiency range from both the engine and heating to the transmission and turbocharger. Controlling the temperature of alternators, hybrid modules and batteries is one of a range of possible tasks that can be performed by this sensor controlled component – they can be efficiently cooled and heated according to requirements using the thermal management module from Schaeffler.

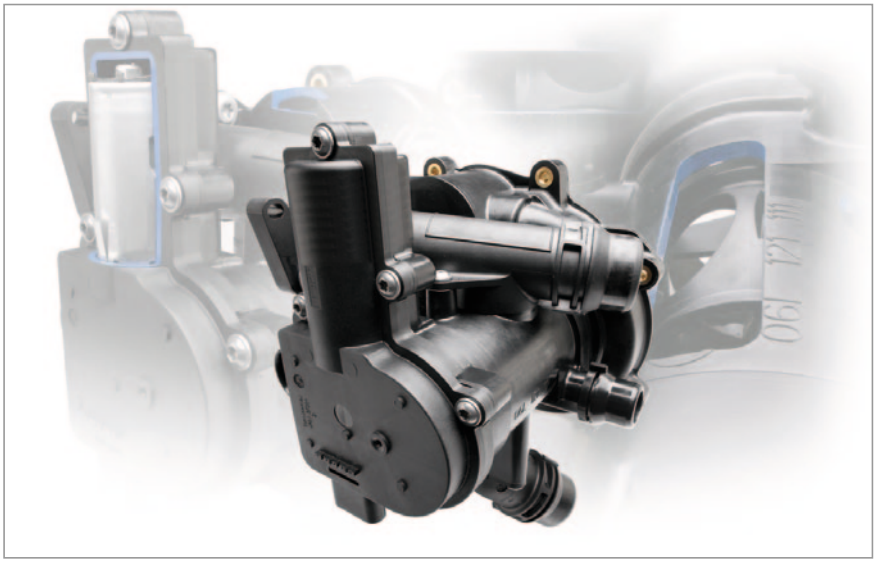
Precise control by means of a rotary slide valve enables the ideal temperature window for the engine and transmission to be reached rapidly. This has an effect on both the energy efficiency and the life of components in the drive chain. The turbocharger can also be included in the components whose temperature is controlled by the thermal management module. Individual control ensures aftercooling of the thermally stressed exhaust gas turbine.

“The performance of the thermal management module makes this component particularly suitable for use in engines for start-stop operation“, says Prof. Peter Pleus,

President of Schaeffler Group Automotive. The individual components of the module are also optimized for friction in accordance with Schaeffler's high requirements in terms of energy efficiency. This means that the thermal management module can be connected directly to the engine control unit without additional power stages thanks to its low power consumption.

The thermal management module also releases developers from the constraint of having to fit the component in close proximity to the engine block – as was always the case with a thermostat located on the engine. Standardized, non-interchangeable hoses reduce assembly times and ensure a high level of seal integrity. This means that Schaeffler's thermal management module makes a valuable contribution to quality.

Images/Captions **Thermal Management Module**



The innovative thermal management module from Schaeffler reduces fuel consumption and CO_2 emissions by up to four percent.

Images/Captions Thermal Management Module

The temperature of the motor, turbocharger and transmission as well as the interior can be precisely controlled with the thermal management module.

Rotary slide valves controlled by sensors enable the ideal temperature window for the engine and transmission to be reached quickly.

Schaeffler innovation revolutionizes in differential construction – lightweight differential creates space for hybrid modules and is the key to the *eDifferential*

Lightweight Differentials Create Space

HERZOGENAURACH, 13 September 2011. More compact, lighter, quieter, more efficient and with higher performance – These are the attributes of the new, innovative lightweight differential from Schaeffler's INA brand. This is made possible by a completely new differential design.

The architecture of this space-saving component is completely different from traditional differential designs. Instead of using conventional differential pinions, the lightweight differential has spur gears arranged as a planetary gear set in one plane, as used in automatic transmissions.

This means that the required space and weight are significantly reduced and the potential torque capacity is noticeably increased. "The lightweight or spur gear differential has enormous advantages", explains Dr. Tomas Smetana, Head of Advance Development at the Transmission Business Unit, Schaeffler Group Automotive. "We save up to 30 percent weight compared with a classic bevel gear differential while creating up to 70 percent more axial space due to the streamlined design. In specific terms, this means a reduction in mass of up to three kilograms per differential and 90 millimeters of additional space in the transmission!" The lightweight differential is thus an appropriate response to the challenge of increasing engine torques and the space gained in the transmission creates more room for larger double clutches or transfer boxes, as well as electronic components for modern hybrid solutions.

"The narrow lightweight differential design also allows the use of new bearing concepts with optimized friction and makes a measurable contribution to reducing fuel consumption and CO_2 emissions", says Norbert Indlekofer, member of the Executive Management Board of Schaeffler Group Automotive and responsible for the Transmission and Chassis systems Business Division.

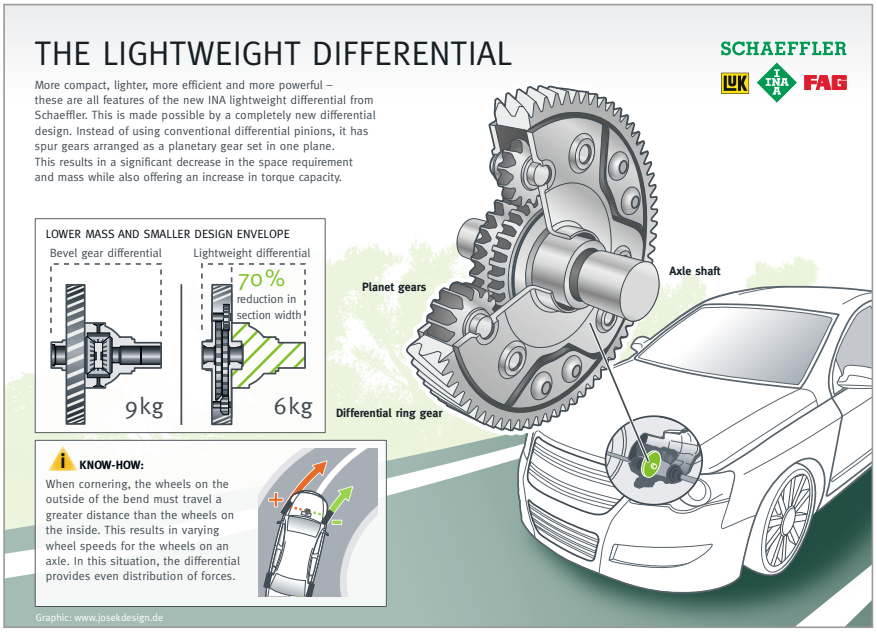
In addition, the lightweight differential – beyond creating space for hybrid modules – is also a key element for the innovative *eDifferential* from Schaeffler. This component combines an electric drive with the option of controlling the drive power in each wheel individually. The active electric differential gives a significant improvement in load transmission when travelling on surfaces with varying friction values.

It also supports the steering function. This facilitates torque vectoring (distribution of torque between the left and right wheel), which is beneficial for driving dynamics, safety and comfort. If *eDifferential*s are used on both axles, this also enables the longitudinal distribution of drive torques. It is also possible to intervene in driving dynamics through selective power supply instead of through braking intervention and thus power reduction as is the case with ESP. With the solution presented in the Schaeffler concept vehicle *ACTIVeDRIVE*, the mobility supplier is showing the way ahead for such an electric concept in a vehicle drive system.

Images/Captions Lightweight Differential

The innovative design of the Schaeffler lightweight differential with the axial spline design gives significant advantages in terms of space, weight and power consumption.

Differentials of the traditional design with bevel gears require significantly more space.



Schaeffler supplies key components for efficient dual clutch transmissions

Dual clutch transmissions – an interplay of innovations

HERZOGENAURACH, 13 September 2011. The dry dual clutch is the key element of what is the most efficient type of transmission worldwide. The number of carmakers and their customers who have been persuaded by the benefits of this highly innovative technology, which has been available since 2008, has risen strongly. Through the use of dry clutch linings, it has been possible to make significant improvements in the energy efficiency of dual clutch transmissions capable of shifting without any interruption to traction power. An advantage is gained in terms of efficiency since there is no need to provide the oil volume flow that would otherwise be required for cooling purposes in so-called wet solutions. In comparison with a classical manual transmission, the lightning fast gearshifting of this transmission technology gives fuel consumption benefits of up to six percent. The essential advantage of this transmission technology is the combination of efficiency and driving enjoyment.

The dry dual clutch – the heart of this efficient transmission technology – is composed of many more parts than is suggested by the term. Together with the electromechanical clutch, the component now supplied in millions of units by the LuK brand of Schaeffler consists of more than 500 individual parts that are produced – depending on the customer's location – in Europe, North America and Asia and joined together to create a fully coordinated unit. "We currently manufacture more than 100,000 dry dual clutches per month" explains Norbert Indlekofer, Vice President of Schaeffler Group Automotive, "and the number of customers and applications is continually on the increase."

The dual clutch is, however, by no means the only contribution made by Schaeffler to this transmission technology. The system is completed by dual mass flywheels specially tailored to the requirements of dual clutch transmissions. The dual mass flywheel acts as a torsion damper and prevents the torsional vibrations originating in the engine from being transmitted into the drive train. It prevents the occurrence of any body boom and so-called gear rattle. It thus makes a decisive contribution towards increasing driving comfort and to driving in fuel-efficient operating points.

The Schaeffler product range also extends well beyond the clutch and damping elements from LuK. It also includes an engagement system designed for dual clutch applications. This comprises an engagement bearing and engagement lever and is fitted, depending on the application, with electrohydraulic or electromechanical

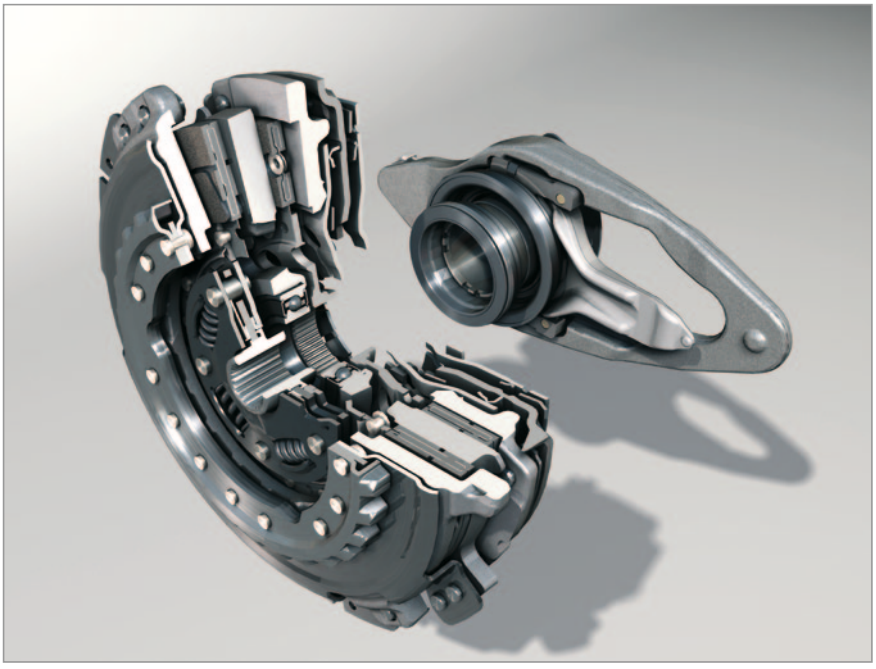
actuator system. The Schaeffler portfolio for dual clutch products also includes the development of control devices that simplify the clutch and actuation mechanism and represent a further component for automated clutch activation.

Furthermore – as with manual or automatic transmissions – a large number of bearing solutions from Schaeffler specifically designed for the requirements of transmissions contribute to the success of dual clutch transmissions. These include needle roller bearings, cylindrical roller bearings, angular contact ball bearings and synchro trings under the Schaeffler brand INA as well as various tapered roller bearings and ball bearings under the Schaeffler brand FAG. “As a result, the total number of individual parts from Schaeffler in a dual clutch transmission runs into the thousands” says Norbert Indlekofer. “In addition, these individual parts are matched to each other and tailored to the specific customer requirements. The perfect interplay is part of the energy-efficient innovation that is celebrating a considerable triumph.”

Images/Captions Dual Clutch Transmissions

Dry dual clutches achieved worldwide success some time ago.

Images/Captions Dual Clutch Transmissions



An LuK dual clutch system consists of more than 500 individual parts.

LuK now manufactures more than 100,000 dry dual clutches per month.

LuK offers both “dry” and “wet” dual clutch solutions.

Overrunning Alternator Pulley Improves Harmony in the Belt Drive and Energy Efficiency

Inconspicuous problem solver for increasing efficiency

HERZOGENAURACH, September 13, 2011. The overrunning alternator pulley is one of the unsung heroes in the field of modern engines. The overrunning alternator pulley is the functional interior of the belt pulley located on the generator. The overrunning alternator pulley decouples the alternator from the rotational irregularities of the crankshaft of an internal combustion engine. It therefore performs a task that must not be underestimated, because the rotational irregularities that occur in modern internal combustion engines are significantly higher than those indicated to the driver by the tachometer needle.

The generator is the component with the greatest mass moment of inertia and the highest speed in the accessory drive. This means that the acceleration and deceleration forces acting on the generator resulting from the rotational irregularity have the greatest effect on the belt transferring these forces. The overrunning alternator pulley ensures that at many operating points only the accelerating proportion of the crankshaft forces that are transferred to the belt drive are used to drive the alternator. The advantages of the alternator pulley with a one-way clutch – which is also called an OAP (overrunning alternator pulley) in the trade – are clear. The reduction in the force level in the belt drive increases the life of individual components while ensuring an increase in the generator speed and a reduction in noise. In addition to increased smoothness, the overrunning alternator pulley makes a contribution to reducing fuel consumption and CO_2 emissions.

A reduction in fuel consumption of almost one percent was measured, for example, with Schaeffler's concept vehicle *CO_2ncept-10%*. Particularly in city traffic – with its high proportion of idling and numerous situations where vehicles are accelerating – a belt drive with an overrunning alternator pulley is subjected to significantly lower loads than a belt drive without an overrunning pulley. Use of the overrunning alternator pulley also enables other components in the overall belt drive system to be designed more cost effectively.

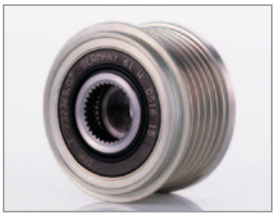
This impressive contribution to improving efficiency also explains why the overrunning alternator pulley has been so successful both in diesel and gasoline engines.

This component, which has now been established for 15 years, was regarded early on as a key component for eliminating the rotational irregularities of the new generation of high-torque, direct-injection diesel engines from the belt drive. The overrunning alternator pulley is now also included in the extensive list of measures for optimizing the fuel consumption of internal combustion engines.

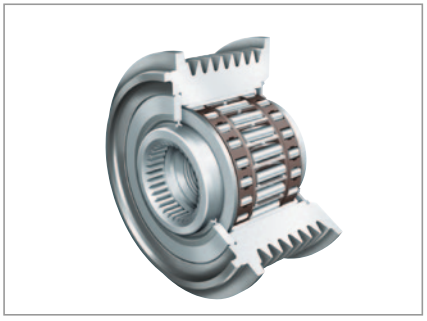
A comprehensive modular system has been developed which offers numerous different customized components with regard to the use of overrunning alternator pulleys in gasoline and diesel engines, passenger cars, commercial vehicles and motorcycles as well as other customer requirements. These include an OAP manufactured partly to aviation specifications which is used in the Schaeffler Audi A4 DTM.

The catalog currently includes more than 400 different belt pulleys with OAP. Over 140 million of these unsung heroes have rolled off the assembly lines in the last 15 years at Schaeffler – and an end to this success story is not in sight.

Images/Captions Overrunning Alternator Pulley

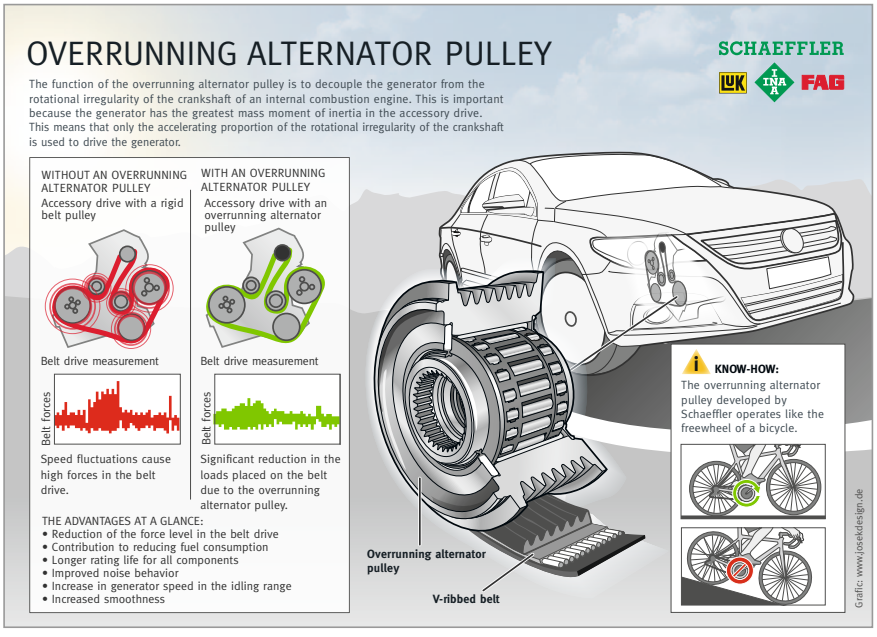


The overrunning alternator pulley is one of the “unsung heroes”. This inconspicuous component reduces vibrations and improves the energy efficiency of modern engines.



The current Schaeffler product range includes more than 400 different overrunning alternator pulleys and more than 140 million of these components have been manufactured in 15 years.

An overrunning alternator pulley manufactured from aircraft-quality aluminum is also used in the Schaeffler DTM Audi.



Rolling Bearing Supports Offer Potential for Optimization in Engine Construction

Rolling bearings are the key to optimizing friction, efficient design and optimizing start-stop systems

HERZOGENAURACH, September 13, 2011. The supplier to the mobility industry and rolling bearing specialist Schaeffler is also offering a good example for the successful use of rolling bearings in engine construction with the lightweight balancer shaft with rolling bearing supports. These rolling bearing supports with reduced friction significantly improve the energy efficiency compared to the plain bearings that were previously used. In the case of the lightweight balancer shaft with rolling bearing supports, the power consumed internally in a four-cylinder diesel engine already in volume production is reduced, for example, by up to 1.5 kW (2.0 horsepower). The rolling bearing supports also reduce the requirement for oil cooling and make the previously obligatory pressure lubrication no longer necessary. These features in conjunction with the superior emergency running characteristics make lightweight balancer shafts with rolling bearing supports particularly suitable for engines with start-stop systems. The rolling bearing supports also enable a new balancer shaft design with an optimized mass that is reduced by around one third. This means the two balancer shafts mounted in an engine, which run at twice crankshaft speed due to the design, reduce engine weight alone by more than a kilogram. The filigree design also minimizes the shaft's rotational inertia and, thus, in turn reduces the driving forces required.

This means that lightweight balancer shafts with rolling bearing supports also make a contribution to reducing fuel consumption and CO_2 emissions as well as increasing smoothness. They are in increasing demand due to the trends for downsizing and downspeeding of engines.

Example: Turbocharger

The turbocharger is an important component for downsizing high-performance gasoline engines and for high-torque diesel engines. The performance of rolling bearing solutions in this application is no less impressive. In specific terms, the rolling bearing supports enable increased torque, improved response as well as reduced consumption and emissions.

The significantly reduced frictional resistance of a turbocharger with rolling bearing supports compared to a component with plain bearing supports results in higher

bearing shaft speeds in the low and partial load ranges. This leads to significantly increased acceleration of the turbocharger in the case of an increased load, and the higher turbocharger speed improves the response of the turbocharger and reduces so-called “turbo lag”. The fresh air supply is optimized and emissions are significantly reduced. The raw emissions in the low and partial load ranges are reduced by a factor of two compared with comparable engines with turbochargers with plain bearing supports. The optimization potential for reducing fuel consumption and CO_2 emissions which has been verified in the NEDC* is up to four percent.

Turbochargers with rolling bearing supports are currently used in motor sport and also on the road in passenger cars and trucks. Accordingly, Schaeffler offers a wide range of turbocharger solutions with rolling bearings, which are available tailor-made for different shaft diameters from 6 to 24 millimeters and come completely assembled in cartridge form. The cartridge design of this product, which is used in a thermally stressed position, ensures the highest-possible precision. This benefits both the quality and ensures a low noise level. “Turbochargers that have been optimized by means of rolling bearing supports can demonstrate their strengths particularly impressively if they are used as part of downsizing measures“, says Dr. Peter Solfrank, who is responsible at Schaeffler for the product group rolling bearings and balancer shafts in engines. “A turbocharger with rolling bearing supports can be used to perform the tasks otherwise performed by two turbochargers that are combined with each other in order to ensure instantaneous response and a high maximum throughput.”

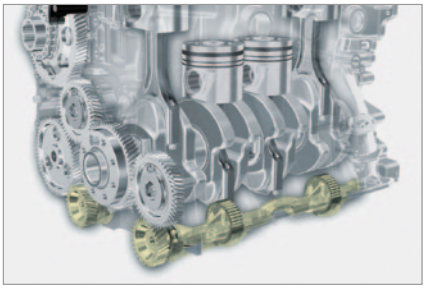
Example: Camshaft

One of the requirements of modern internal combustion engines is that their design must now generally be suitable for use in start-stop systems. Rolling bearing supports also offer significant advantages due to the principle that they prevent mixed friction conditions. Camshafts and gears in the timing drive are therefore amongst the further applications for rolling bearings in engines. Optimized frictional resistance, the ability to compensate for increased radial loads and tilting moments, optimized lubrication requirements and an axial guidance facility are the significant advantages of rolling bearing solutions.

* NEDC = New European Driving Cycle

Images/Captions Lightweight Balancer Shaft

The lightweight balancer shaft with rolling bearing supports has also received the PACE Award and the Steel Innovation Prize.



The rolling bearing supports reduce friction and enable a new balancer shaft design with an optimized mass.

Schaeffler Automotive

Higher fuel economy, lower emissions, improved safety and greater driving pleasure

HERZOGENAURACH, September 13, 2011. Schaeffler is a renowned supplier to the automotive industry worldwide. Sales in this sector from Schaeffler's Automotive division account for around 60 percent of the company's sales. Schaeffler's reputation in the Automotive division is based on a wide range of innovative products and components. The product range includes wheel bearings, chassis, steering and transmission components and developments and engine components and valve control systems. Schaeffler innovations are helping to prepare the automobiles of today and tomorrow for the challenges of the future. Schaeffler is making a substantial contribution to the successes of modern automotive manufacturing; especially in terms of energy efficiency and therefore in minimizing fuel consumption and emissions.

As well as reducing fuel consumption and emissions, Schaeffler's innovations make an important contribution to increasing safety and driving pleasure. Above all, this involves chassis, steering and transmission components. Innovative spirit and manufacturing expertise ensure that Schaeffler is one of the most important companies in the automobile industry.

As a reliable engineering partner, Schaeffler makes a convincing case for its customers with its outstanding innovative ability, customer proximity and availability worldwide. The permanent focus on the highest-possible quality and the ability to react quickly to individual requirements are the acknowledged advantages Schaeffler offers.

Close cooperation with renowned automobile manufactures has a long tradition at Schaeffler. It continuously leads to innovations that numerous manufacturers translate into competitive advantages.

UniAir, camshaft phasing systems, belt drive systems and overrunning alternator pulleys, lightweight differentials with face spline, dual mass flywheels and lightweight balancer shafts, fundamental components for CVT, Porsche dual clutch transmissions and direct-shift transmissions, twin tandem bearings or wheel bearings with face spline – Schaeffler's product range based on its extensive know-how is immense.

Elements and systems from Schaeffler's various brands (LuK, INA, FAG) can be found in the vehicles of almost all manufacturers, whether in Europe, Asia, South or North America. On average, every car worldwide contains around 60 components from Schaeffler.

Images/Captions Schaeffler

Schaeffler has a worldwide network of more than 180 locations. The company is headquartered in Herzogenaurach, Germany.

SCHAEFFLER

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LuK INA FAG