

SCHAEFFLER

Efficient Future Mobility

eSolutions

eMobility

Light Weight

Low Friction

advanced Drive

Fuel Economy

Eco-friendly

CO₂ Reduction

creative technology

innovative systems

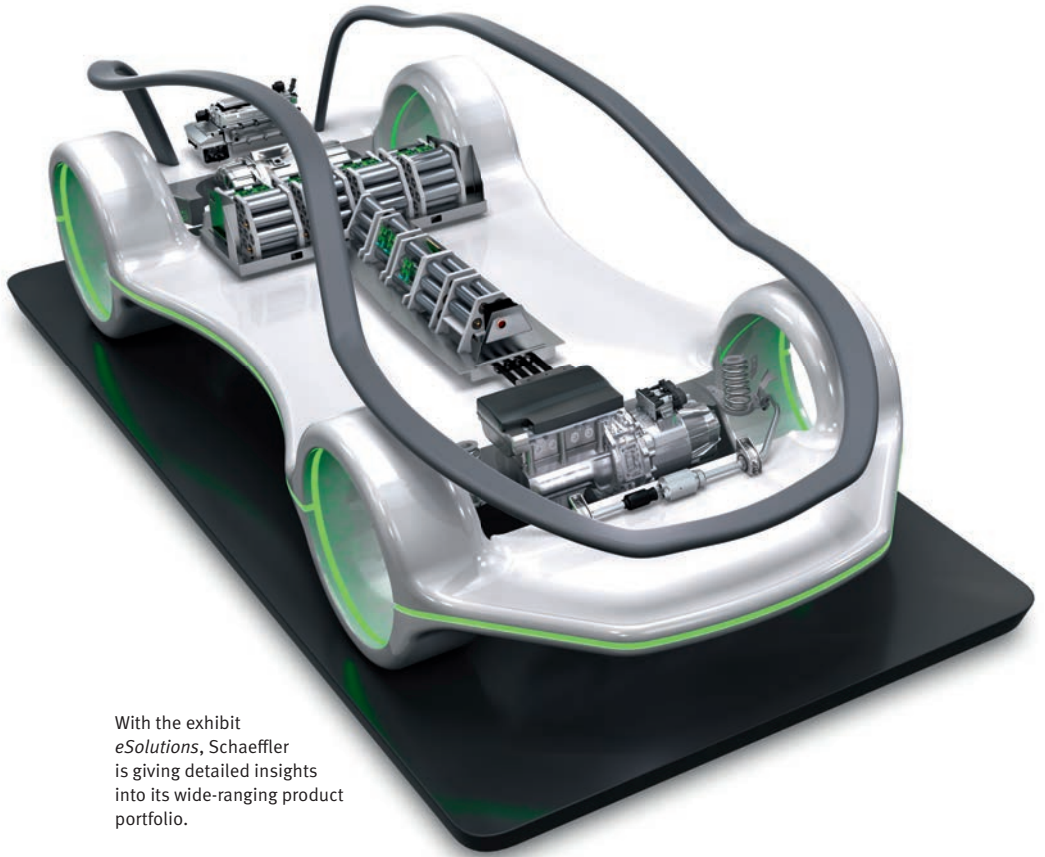
Hybrid Technologies

Energy Efficiency



NAIAS 2012

Press Kit



With the exhibit *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.

Efficient Future Mobility

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

Detroit 2012: Versatile Expertise for Efficient Mobility 4

Schaeffler is using a diversification strategy

Schaeffler demonstrates diversification strategy with *CO₂ncept-10*, *Schaeffler Hybrid* and *ACTIVeDRIVE* concept vehicles

Schaeffler Presents Diversity in Automobility 7

Schaeffler Innovations

Schaeffler showcases torque converter innovations

More Compact, Efficient and Versatile 13

Electric Mobility

Schaeffler presents *ACTIVeDRIVE* concept car for electric mobility

ACTIVeDRIVE – Electric Vehicle with Active Torque Distribution 16

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 19

Energy Efficiency

Schaeffler thermal management module optimizes not only the temperatures of engines and transmissions but also hybrid components and batteries

Innovative Thermal Management Module Improves CO₂ Footprint 23

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 26

Schaeffler supplies key components for efficient double clutch transmissions

Double Clutch Transmissions – An Interplay of Innovations 29

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

Lightweight Differentials Create Space 32

About Schaeffler

Schaeffler Automotive

Higher Fuel Economy, Lower Emissions, Improved Safety and Greater Driving Pleasure 35

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

Detroit 2012: Versatile Expertise for Efficient Mobility

- Mobility of the future will be driven by electric mobility and optimized internal combustion engines in equal measure
- Schaeffler lays 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 pollutant emissions
- Schaeffler gains more than proportional benefit from the enduring trend in energy efficiency

HERZOGENAURACH/DETROIT, January 9, 2012. The North American International Auto Show (NAIAS), taking place from January 9 – 22, 2012 in Detroit, will see Schaeffler Automotive unveiling a number of forward-looking innovations. The trade show is being held right on the doorstep of the “Detroit Three” – the USA’s three largest automobile manufacturers – and traditionally marks the start of the new year for the automobile industry.

The exhibits that Schaeffler will be presenting in Detroit include both innovations for optimizing conventional drive trains based on the internal combustion engine and a variety of hybrid solutions and electric mobility products. The Schaeffler *eSolutions* concept model is a showcase for a number of interesting innovations, such as the *eWheel Drive* electric wheel hub drive (winner of the eCarTec Award) and the pioneering *eDifferential* – an electric axle that allows both the specific distribution of the drive torque to individual wheels and torque vectoring, and thus provides unique driving dynamics in electric and hybrid vehicles. “Electric mobility will make a significant contribution to driving our business”, says Prof. Peter Gutzmer, Chief Technology Officer at Schaeffler, in reference to the significantly increasing number of vehicles – both fully electrically driven and utilizing hybrid technology – that are now incorporating electric drive components.

In order to dedicate the appropriate attention to this field, 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, the issue of electric mobility for Schaeffler also includes considerations for the infrastructure associated with it, which is why the company has been one of the key suppliers to the wind power sector and other areas in renewable energy from the very beginning.

Innovations from Schaeffler that make a significant contribution to increasing the efficiency of vehicles with conventional drive trains are also generating a high level of interest. “After all, the majority of all automobiles in the future will still have internal combustion engines, serving either as the single or primary drive source, or as a range extender“, explains Prof. Peter Gutzmer. “These internal combustion engine drive trains still have a great deal of room for improvement in terms of fuel consumption and CO₂ emissions – 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, Member of the Executive Board Engine Systems at Schaeffler. “Start-stop systems place special requirements on different components, and Schaeffler offers a wide range of customized solutions to fulfill each of these.”

Innovations in torque converter technology, the thermal management module, and components for variable valve trains will also be among the exhibits taking center stage in Detroit. “With its *efficient future mobility* motto, Schaeffler continues to consistently pursue the path it has always traditionally taken“, says Dr. Juergen M. Geissinger, CEO of Schaeffler. “Energy efficiency is deeply embedded in Schaeffler’s genes. And Schaeffler’s numerous successful products and promising innovations, as well as its extensive development network and global manufacturing expertise, mean the company is in an excellent position. 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 automobiles of today and tomorrow. This makes Schaeffler a global supplier of expertise for *efficient future mobility*“, Dr. Geissinger sums up. “In North America too the focus of the automotive industry is on reducing fuel consumption and pollutant emissions. Schaeffler’s wide range of products and new innovations make valuable contributions in this respect, which ensures that we grow faster than the market in this region too.”

Images/Captions *Efficient future mobility*



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

Schaeffler demonstrates diversification strategy with *CO₂nccept-10*, *Schaeffler Hybrid* and *ACTIVeDRIVE* concept vehicles

Schaeffler Presents Diversity in Automobility

HERZOGENAURACH/DETROIT, January 9, 2012. 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 *CO₂nccept-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.

CO₂nccept-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, Member of the Executive Management Board responsible for technical development at Schaeffler.

ACTIVeDRIVE – an innovative and dynamic electric vehicle

The main innovation of Schaeffler's *ACTIVeDRIVE*, which is based on a Skoda 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 eDifferentials 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 *ACTIVE*DRIVE 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 ‘*CO₂n-cept-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), electro-

mechanical chassis and steering components, as well as various differentials. These differentials include the space-saving lightweight differential and the eDifferential in the *ACTIVeDRIVE*.

***CO₂nccept-10%* demonstrates potential for optimization in drive trains with internal combustion engines**

The *CO₂nccept-10%* vehicle is a joint advance development project implemented by Porsche and Schaeffler that has achieved a total reduction in fuel consumption and CO₂ 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 *CO₂nccept-10%* is a CO₂ 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 CO₂ 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. “CO₂ncept-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. CO₂ncept-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 CO₂ncept-10%, Schaeffler Hybrid and ACTIVEeDRIVE



The Schaeffler concept vehicles CO₂ncept-10%, Schaeffler Hybrid and ACTIVEeDRIVE show the wide-ranging spectrum of modern automotive engineering and give a perspective on the extensive Schaeffler product portfolio.

Images/Captions *CO₂ ncept-10%*, *Schaeffler Hybrid* and *ACTIVEeDRIVE*



With the *CO₂ ncept-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*.



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

Schaeffler showcases torque converter innovations

More Compact, Efficient and Versatile

HERZOGENAURAH/DETROIT, January 9, 2012. The majority of all newly registered cars in North America feature automatic transmissions with torque converter. There isn't anywhere else in the world where the proportion of this type of transmission comes even close. This makes automatic transmissions with torque converter "the" transmission in the North American market. Formerly ill-reputed as being inefficient, ongoing R&D activities have advanced these transmissions to offer exemplary efficiency. Modern torque converters do not fall short of manual transmissions and double clutch systems in terms of energy efficiency.

More compact, lighter and more efficient – these attributes characterize today's generation of torque converters of the Schaeffler brand LuK. Thus they fully satisfy the requirements of automotive manufacturers and ultimately, of the drivers too. They want to drive environmentally friendly cars; albeit without giving up the comfort they are accustomed too. This is exactly what Schaeffler offers: Vehicle components that help reduce emissions and fuel consumption, whilst increasing the driving comfort and performance.

Taking a look at the new torque converter generation W238 reveals just how much the development has progressed. The key technical data of this generation are: 400 Nm torque and a hydraulic diameter of 238 millimeters. And all of this with a weight of only 14 kilograms and a hydraulic width of just about 5 centimeters. The previous version, W258, weighed in at over 17 kilograms and measured 258 mm in diameter as well as being nearly 70 mm wide. More compact, lighter and yet more efficient – the comparison of these two generations puts it in a nutshell.

Since 1998 Schaeffler has been strengthening its position in the USA by setting up its own torque converter development and production facilities in Wooster/Ohio. The location serves as a center of competence in Schaeffler's global development network, which comprises 5,500 engineers and technicians.

Continued development work is an important aspect for ensuring the market success of the LuK torque converter. But the company's innovative strength is just as important. Time and time again, it enables spectacular technology leaps to be achieved. For example, the introduction of the centrifugal pendulum-type absorber virtually revolutionized the field of converter technology. This product has set new

standards in the optimization of torque converters. It provides the appropriate answer for automatic transmissions when it comes to the two main trends in engine development: downspeeding and downsizing.

Successfully used in Europe in combination with the dual-mass flywheel, the innovative centrifugal pendulum-type absorber reduces vibration in the drivetrain, thus ensuring lower fuel consumption and emissions as a result of reduced speeds – is now also available for torque converter transmissions. This means the foundations have now been laid for great success in the USA in particular.

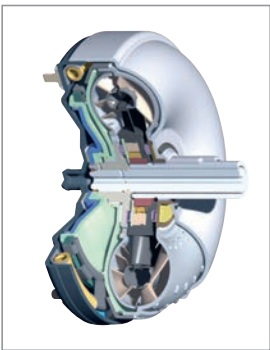
The function of the centrifugal pendulum-type absorber is simple: In the new converters, a centrifugal pendulum-type absorber is located on the turbine side of the converter and operated in the oil chamber. A spring damper provides basic isolation of vibrations when the lockup clutch is closed, the remaining irregularities are almost totally canceled out by the centrifugal pendulum-type absorber. The maximum speed fluctuations in the differential input can easily be reduced in this way by more than 70 percent compared to a conventional damper – ideal prerequisites for reducing fuel consumption and CO₂ emissions.

Marc McGrath, Head of the Torque Converter Product Line in the USA, is proud of the new product: “The centrifugal pendulum-type absorber sets another milestone in the history of the converter. A reduction in fuel consumption combined with an improvement of driving comfort, where else can you find that? I am sure the North American market will soon recognize the advantages of this converter with centrifugal pendulum-type absorber.”

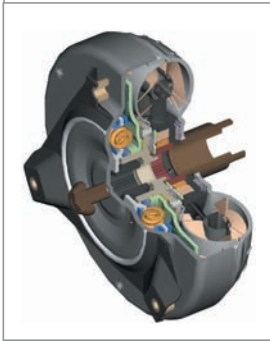
Another converter innovation has been tailored to modern, charged engines and is a revolutionary invention in the field of torque converters: The multi-function torque converter (MFTC) can be ideally combined with start-stop systems and is capable of compensating for the customary delayed response behavior, also known as turbo lag. In addition, the multi-function converter enables a reduction in fuel consumption of up to 5 percent to be achieved, using idle disconnect and the early lock-up of the converter. The disconnection of the transmission and the engine made possible through the MFTC eliminates idle losses of the converter. Moreover this converter configuration allows a more favorable distribution of the mass moments of inertia, which results in excellent vibration isolation in all driving situations. Thanks to this engine disconnection, the engine is able to reach higher start-up speeds as soon as the torque converter is activated. This leads to significant improvements in the launch behavior of turbo-charged vehicles and is a key to overcoming the dreaded turbo lag.

“With the dual-mass flywheel invented by LuK some time ago, we came up with a solution for effectively eliminating vibration in the drivetrain of manual transmission vehicles,” says Norbert Indlekofer, Member of the Schaeffler Executive Board in charge of Transmission Systems. “With the centrifugal pendulum-type absorber and the multi-function torque converter we are now presenting a corresponding solution for vehicles with automatic transmissions. The latest torque converter innovations of the LuK brand impressively document the performance capability of this comfort and performance oriented component at the heart of the advanced automobile.”

Images/Captions Torque Converter



MFTC (multi-function torque converters) are tailored to modern, charged engines and are considered as revolutionary invention in the field of torque converters.



Smaller, lighter, more efficient – today’s torque converter generation is optimized for exemplary efficiency.

Schaeffler presents *ACTIVE*DRIVE concept car for electric mobility

ACTIVEDRIVE – Electric Vehicle with Active Torque Distribution

HERZOGENAURACH/DETROIT, January 9, 2012. Schaeffler is presenting its *ACTIVE*-*DRIVE* concept vehicle for electric mobility. It complements the trio of demo vehicles with which Schaeffler is visualizing the spectrum of modern automobility. “These three cars are full of ideas and function as platforms for the testing of various components and systems under realistic conditions,” says Prof. Dr.-Ing. Peter Gutzmer, Member of the Executive Board and responsible for technical development at Schaeffler.

The *ACTIVE*DRIVE is a purely electric vehicle with four-wheel drive, based on a Skoda Octavia Scout. The three vehicles – *CO₂concept-10%*, *Schaeffler Hybrid* and *ACTIVE*-*DRIVE* – represent Schaeffler’s broad-spectrum strategy and product portfolio.

- With its *CO₂concept-10%* vehicle based on the Porsche Cayenne, Schaeffler is impressively demonstrating the improvement potentials that can be achieved through consistent detailed work on vehicles with internal combustion engines. In the case of the *CO₂concept-10%*, these optimization measures cover detailed solutions that are already available or close to series production, but do not touch the basic configuration. Moreover, the optimization of the classic drive train also includes the use of electrified components instead of the previous hydraulically actuated elements.
- Based on a compact Opel Corsa, the *Schaeffler Hybrid* serves as an ‘ideas’ vehicle and a practice-oriented testing laboratory for various hybrid solutions. This versatile and variable advance development project enables a practical comparison of a wide range of options in the field of electric mobility. The driving modes represented range from classic operation with internal combustion engine and operating modes as parallel and serial hybrid with range extender to fully electric driving.
- The *ACTIVE*DRIVE is a thoroughbred electric vehicle (BEV: Battery Electric Vehicle).

These three vehicles provide an overview of Schaeffler’s wide product portfolio which ranges from energy-efficient solutions for the classic drive train with internal combustion engine all the way through to products for hybrid vehicles and elements for purely electric vehicles.

The major innovation of the Schaeffler *ACTIVE DRIVE* is its active electric differential (eDifferential) which is installed both on the front and on the rear axles. This component combines the electric drive with the option of wheel-selective drive power control. This enables torque vectoring (torque distribution between the right and the left wheel), which enhances driving dynamics, driving safety and driving comfort. “The eDifferential permits active intervening in driving dynamics through well-aimed power supply – instead of braking intervention and thus power reduction, as is the case with the ESP. The active electric differential significantly improves power transmission when driving on surfaces with different friction coefficients. Moreover it assists the steering and has a clearly positive effect on driving dynamics, driving safety and driving comfort. In addition, the use of two eDifferentials enables the longitudinal distribution of drive torques,” explains Prof. Dr.-Ing. Gutzmer. The possibility of active longitudinal and lateral distribution of drive torques makes the eDifferential an ideal platform for innovative vehicle dynamics control systems. With the solution shown in the *ACTIVE DRIVE*, Schaeffler is a pioneer in such electric concepts for vehicle drives.

The actively controllable torque distribution enables torque vectoring, which means that the vehicle can be controlled virtually without the use of steering and braking by means of a wheel-selective flow of forces. “So the potential fields of application for the eDifferential range from sports cars with extremely high driving dynamics and vehicles of classic automobile categories to agricultural machines,” explains Dr. Tomas Smetana, Senior Manager Advance Development Power Transmission Systems at Schaeffler Automotive.

The eDifferential system integrates two water-cooled permanent magnet synchronous machines (PMSM) of different dimensions, a planetary gear, a gearbox for active torque distribution and – a central element – a Schaeffler lightweight differential. The electric machines come from Schaeffler’s brand IDAM. The larger PMSM, which delivers up to 105 kW and 170 Nm, is responsible for the drive. The second PMSM, which controls the torque distribution, must deliver merely 5 kW output to generate up to 2000 Nm of torque difference to the axle. Other innovations shown in conjunction with the *ACTIVE DRIVE* include an integrated electromechanical parking lock, a new forced lubrication system without oil pump for the gearbox, sheet metal planetary carriers and various high-speed and friction-optimized bearing solutions. The electronic control is supplied by AFT and thus comes from Schaeffler as well.

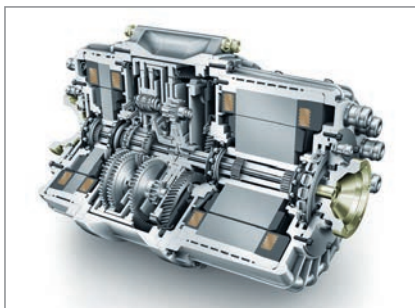
Due to the use of two active electric differentials, the concept car has an overall output of up to 210 kW and features four-wheel drive. Fitted in the cardan tunnel and in front of the rear axle, Li-ion batteries with a capacity of 18 kWh function as energy

storage devices. Thanks to its performance and traction capacity, the 1,900-kilogram test platform accelerates from a standstill to 100 km/h in merely 8.5 seconds. There is an electronic top speed regulation at 150 km/h. The vehicle's cruise range in this configuration amounts to up to 100 kilometers.

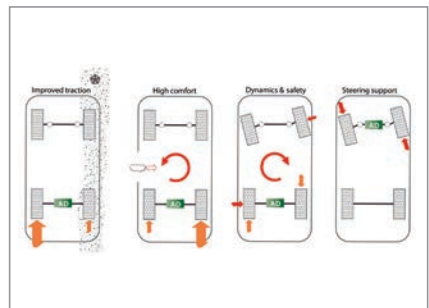
Images/Captions Electric mobility



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



The heart of the ACTIVE DRIVE 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.

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

HERZOGENAURAH/DETROIT, January 9, 2012. 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

THE SERIAL HYBRID

The Schaeffler hybrid is a car full of ideas for electric mobility. This mobile development laboratory demonstrates different drive concepts. This hybrid arranged in series can be driven, for example, all electrically and is therefore very similar to an all-electric car. The serial hybrid obtains the energy required from the battery. The internal combustion engine does not have any mechanical connection to the wheels and acts as a power generator for the battery.

KNOW-HOW: WHAT IS A RANGE EXTENDER?

An engine fitted in a hybrid vehicle to extend its range is called a range extender. An internal combustion engine usually generates electrical current using a generator for operating the electric motor.

0-60 km/h | above 60 km/h

SERIAL HYBRID: SCHEMATIC DIAGRAM OF SETUP

- Internal combustion engine: The engine is used in combination with the generator solely to supply electrical current.
- Electric generator: is driven by the internal combustion engine and generates electrical current for the electric drive motor.
- The battery stores energy for all-electric operation.
- The electric drive motor operates as a motor during vehicle operation, but can also act as a generator and recover energy during braking (recuperation).

THE SCHAEFFLER HYBRID

Graphics: www.presscenter.gm.de



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



Images/Captions Electric mobility



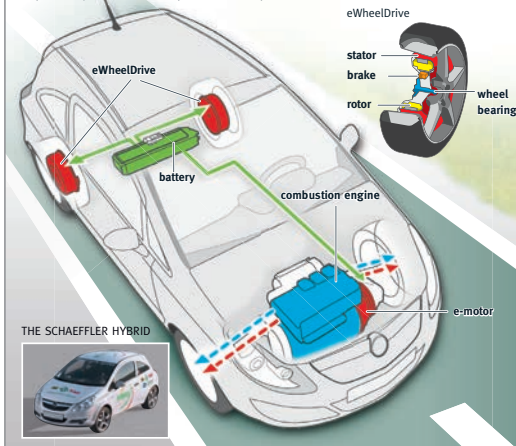
The spectrum of Schaeffler components for e-mobility also includes sensor bottom bracket bearings.

THE PARALLEL HYBRID

The Schaeffler hybrid is a car full of ideas for electric mobility. This mobile development laboratory demonstrates different drive concepts. In a parallel hybrid, an electric drive operates in parallel with a classic internal combustion engine. This means that both units can have smaller dimensions, lower consumption and are more cost-effective. The parallel hybrid can move off solely under electric power and a manually selectable four wheel drive is also possible. The power of the electric motor can also be connected temporarily, practically as a booster, to provide more rapid acceleration.

SCHAEFFLER

LUK INA FAG



KNOW-HOW: WHAT IS A MICRO HYBRID?

A micro hybrid is a vehicle with a start-stop system that forms the first step towards hybridization. A small electric motor (starter generator) replaces the conventional starter and generator. Recuperation (energy recovery during braking) can also be part of this concept.

PARALLEL HYBRID: SCHEMATIC DIAGRAM OF SETUP

- The battery is used as an energy store for the electric motor.
- The electric motor assists the internal combustion engine (to a lesser extent in the mild hybrid).
- The internal combustion engine performs – as in a conventional vehicle – the “lion’s share” of the work to drive the parallel hybrid.
- The transmission controls the transmission of forces from the internal combustion engine and electric motor to the wheels.



Graphics: www.porsche.de/gra

Schaeffler thermal management module optimizes not only the temperatures of engines and transmissions but also hybrid components and batteries

Innovative Thermal Management Module Improves CO₂ Footprint

HERZOGENAURACH/DETROIT, January 9, 2012. 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 CO₂ 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.

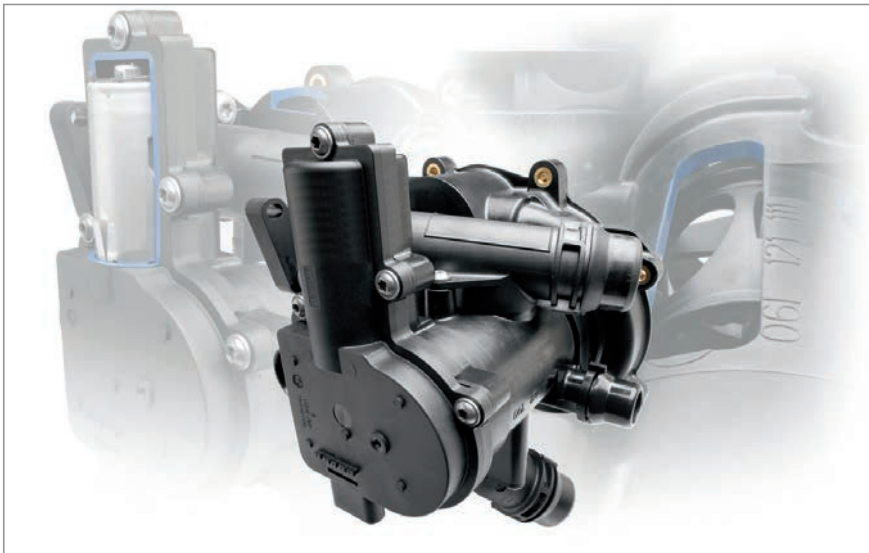
Precise control by means of a rotary slide valve enables the ideal temperature window for the engine and transmission to be reached rapidly. This has an effect on both the energy efficiency and the life of components in the drive chain. The turbocharger can also be included in the components whose temperature 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, Mem-

ber of the Executive Board responsible for engine systems at Schaeffler. 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 CO₂ emissions by up to four percent.



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.

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/DETROIT, January 9, 2012. 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 CO₂ 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 CO₂ 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

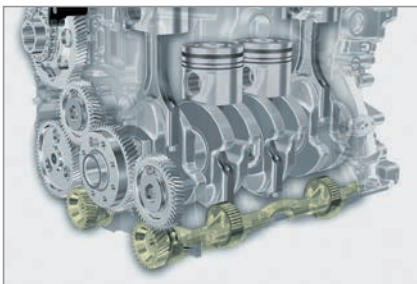
Amongst the additional requirements for modern internal combustion engines is that their design must be suitable for use in start-stop systems. Rolling bearing supports also offer significant advantages due to the principle that they prevent mixed friction conditions. Camshafts and gears in the timing 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 supplies key components for efficient double clutch transmissions

Double Clutch Transmissions – An Interplay of Innovations

HERZOGENAURACH/DETROIT, January 9, 2012. The dry double 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 double 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 double 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 double clutches per month” explains Norbert Indlekofer, Member of the Executive Board responsible for transmission systems, “and the number of customers and applications is continually on the increase.”

The double 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 double 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 double clutch

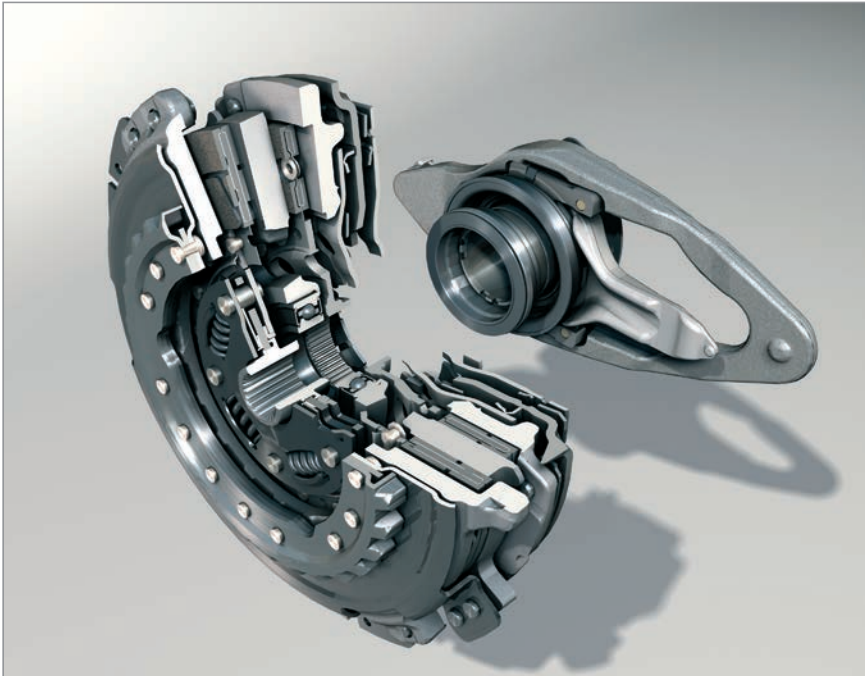
applications. This comprises an engagement bearing and engagement lever and is fitted, depending on the application, with electrohydraulic or electromechanical actuator system. The Schaeffler portfolio for double clutch products also includes the development of control devices that simplify the clutch 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 double clutch transmissions. These include needle roller bearings, cylindrical roller bearings, angular contact ball bearings and synchro rings 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 double 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 Double Clutch Transmissions



Dry double clutches achieved worldwide success some time ago.



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



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



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

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/DETROIT, January 9, 2012. 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 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 CO₂ emissions”, says Norbert Indlekofer, member of the Executive Board and responsible for transmission systems at Schaeffler.

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 dynam-

ics, safety and comfort. If eDifferentials 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.

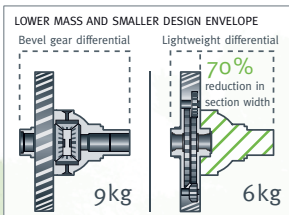
Images/Captions Lightweight Differential



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

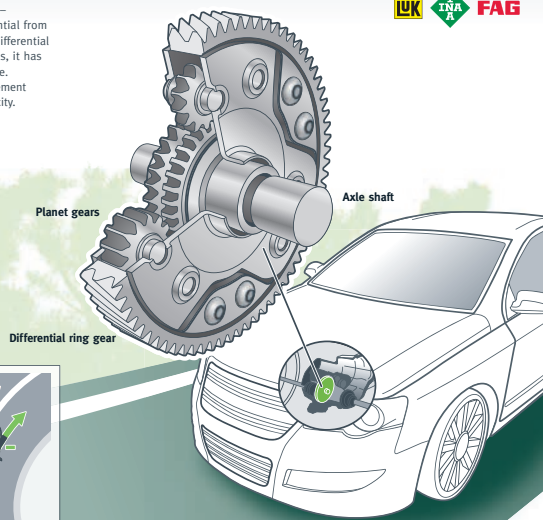
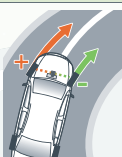
THE LIGHTWEIGHT DIFFERENTIAL

More compact, lighter, more efficient and more powerful – these are all features of the new INA lightweight differential from Schaeffler. This is made possible by a completely new differential design. Instead of using conventional differential pinions, it has spur gears arranged as a planetary gear set in one plane. This results in a significant decrease in the space requirement and mass while also offering an increase in torque capacity.



KNOW-HOW:

When cornering, the wheels on the outside of the bend must travel a greater distance than the wheels on the inside. This results in varying wheel speeds for the wheels on an axle. In this situation, the differential provides even distribution of forces.



Graphic: www.josekdesign.de

Schaeffler Automotive

Higher Fuel Economy, Lower Emissions, Improved Safety and Greater Driving Pleasure

HERZOGENAURAH/DETROIT, January 9, 2012. 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 manufacturers 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, 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

Contacts

Jörg Walz
Schaeffler AG
Head of Communication
Schaeffler Automotive
Industriestraße 1-3
91074 Herzogenaurach
Germany

Tel.: +49 9132 / 82-7557
Fax: +49 9132 / 82-3584
E-Mail: joerg.walz@schaeffler.com

Richard Neilson
Schaeffler Group USA Inc.
Marketing Manager
North American Automotive Center
1750 E. Big Beaver Road
Troy, Mi. 48083

E-Mail: richard.neilson@schaeffler.com

Photos available at:
www.schaefflergroup.com/press-NAIAS/Detroit

