

SCHAEFFLER

Efficient Future Mobility

Eco-friendly

innovative systems

Energy Efficiency

Hybrid
Technologies

eMobility

System 48 V

creative technology

CO₂ Reduction

Fuel Economy

Light Weight

Low Friction

NAIAS 2014

Press Kit



SCHAEFFLER



With the *Efficient Future Mobility North America* demonstration vehicle Schaeffler will be showing how the use of selected products can allow even one of the SUVs popular in America to fulfill the CAFE requirements for the year 2020 in a cost-effective way.

About Schaeffler

Schaeffler, with its product brands INA, LuK and FAG, is a leading provider of rolling bearing and plain bearing solutions and of linear and direct drive technology, as well as a renowned supplier to the automotive industry of high-precision products and systems for engines, transmissions, and chassis applications. The globally active group of companies generated sales of approximately 11.1 billion euros in 2012. With approximately 78,000 employees worldwide, Schaeffler is one of the largest German and European industrial companies under family ownership. With 180 locations in over 50 countries, Schaeffler has a worldwide network of manufacturing locations, research and development facilities, sales companies, engineering offices, and training centers.

Main customer is the automotive industry with around 70 percent of the sales. Schaeffler is a renowned development partner to the industry with system expertise

Schaeffler's expertise allows potential for efficiency to be tapped and emissions regulations to be fulfilled

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Custom-built for North America, suitable for the whole world

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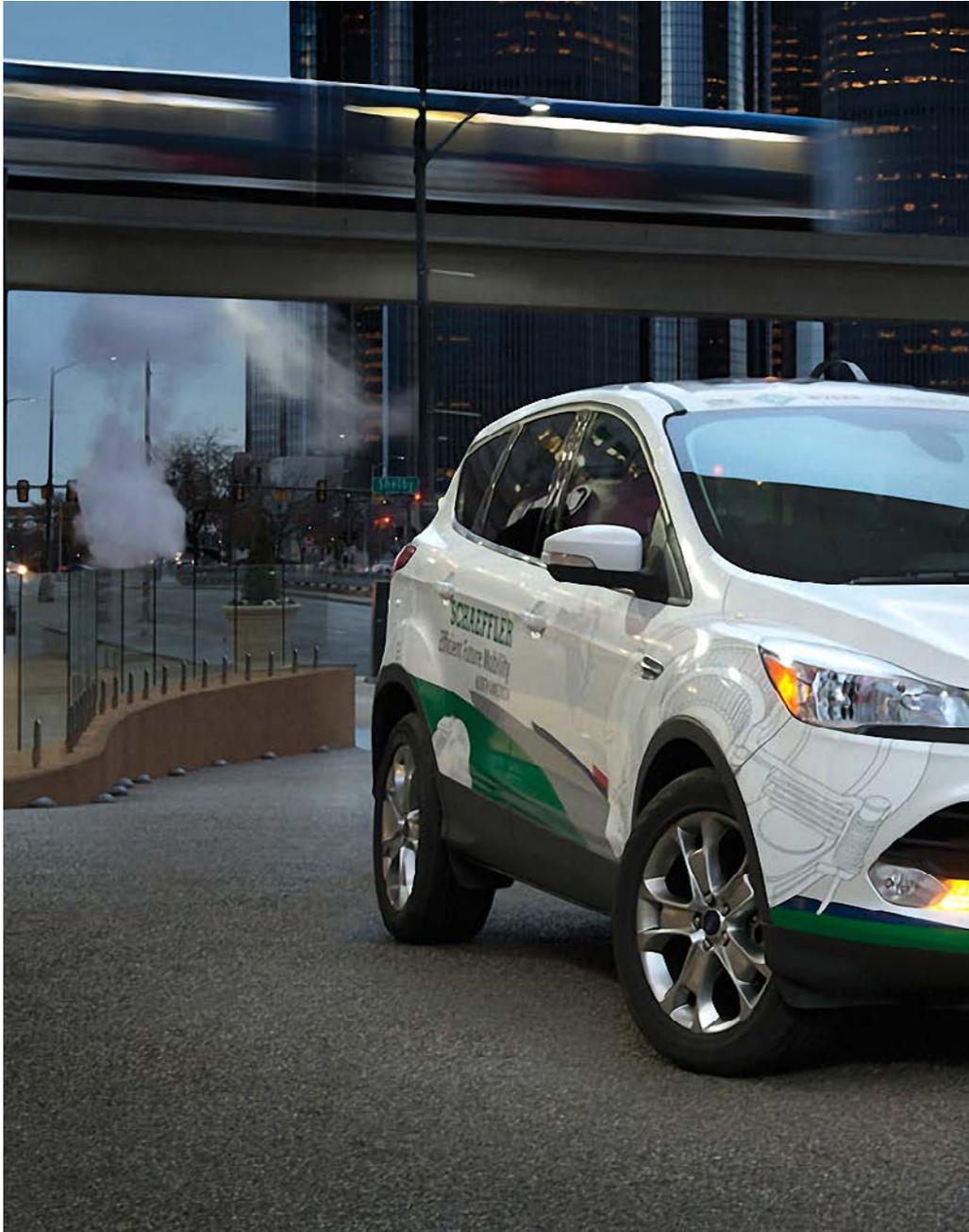
Higher fuel economy, lower emissions, improved safety, and greater driving pleasure

Schaeffler Automotive **30**

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.

To serve the North American automotive market, Schaeffler operates development centers in: Troy, MI; Fort Mill, SC; Wooster, OH; and Puebla, Mexico. The company's 400 North American engineers and technicians, who are supported by a team of more than 6,000 global engineers, drive development in the region utilizing state-of-the-art test and measurement equipment, computational tools and CAD systems. Schaeffler Automotive has headquarters in Fort Mill and manufacturing facilities in: South Carolina; Missouri; Ohio; Ontario, Canada; Puebla and Irapuato, Mexico.

Images/Captions Schaeffler demonstration vehicle *Efficient Future Mobility North America*





Schaeffler Presents Volume Production-Ready Solutions for Achieving the 2020 CAFE Standards and an Outlook on Innovations for Increased Efficiency in Detroit

Schaeffler's expertise allows potential for efficiency to be tapped and emissions regulations to be fulfilled

- *Efficient Future Mobility North America* concept vehicle demonstrates volume production-ready solutions for achieving the 2020 CAFE standards
- Schaeffler's 48-volt products pave the way for further cost-effective increases in efficiency with a view towards the CAFE restrictions in 2025

DETROIT/HERZOGENAURACH, January 13, 2014. The North American International Auto Show (NAIAS) has long been established as the automotive sector's way of ushering in the new year. In 2014, the Detroit trade show is taking place from January 13 to 26. As a supplier to the industrial and automotive sectors, Schaeffler's focus in the capital of the USA's automotive industry is on the CAFE standards. CAFE stands for Corporate Average Fuel Economy and describes the USA's increasingly restrictive legal regulations for "fleet consumption" with regard to the targets set for 2020 and 2025.

With the *Efficient Future Mobility North America* demonstration vehicle on display at its trade show booth, Schaeffler will be showing how the use of selected products can allow even one of the SUVs popular in America to fulfill the CAFE requirements for the year 2020 in a cost-effective way. The experts at Schaeffler's three North American R&D centers in Troy (Michigan), Fort Mill (South Carolina), and Wooster (Ohio) trimmed the mid-size SUV-based concept vehicle for exemplary levels of efficiency by carrying out holistic, detailed work on the powertrain. A total fuel saving of more than 15 percent – both for urban and highway driving profiles – was verified in real driving operation using a range of solutions that are close to volume production status.

Schaeffler's broad range of innovative products for powertrain and chassis applications makes the company an important and capable partner for the global automobile industry, especially when it comes to efficient mobility. "Meticulously detailed work and new solutions for powertrains based on internal combustion engines still offer significant potential for reducing fuel consumption and emissions" explains Prof. Peter Gutzmer, CTO at Schaeffler AG. "And the electrifi-

cation of the powertrain additionally helps to operate the internal combustion engine in its optimum range and to compensate for weak starting performance, so hybridization will continue to make rapid advances. Start-stop systems are becoming increasingly widespread and are set to develop from conventional starters into systems that can even provide features previously only available in hybrid vehicles. And energy recuperation will become more and more of an issue as the performance of on-board electric systems and equipment increases – after all, a reduction in the vehicle’s fuel consumption and CO₂ emissions can also be achieved if this energy is used to drive the vehicle”.

Accordingly, Schaeffler’s product range also includes a large number of innovations for the electrification of the powertrain. This encompasses comfortable and high-performance engine start-stop functions, hybrid clutches, hybrid modules, and drives for hybrid and electric vehicles.

Many of Schaeffler’s ideas for hybrid vehicles with a high-performance low-voltage power system are bundled together in Schaeffler’s *48 V System* exhibit. These ideas also demonstrate how the CAFE standards for 2025 can potentially be fulfilled in a cost-effective way. The central element is a 48-volt drive module. “The use of a 48-volt solution provides an ideal entry-level hybridization that makes it possible to reduce fuel consumption and CO₂ emissions by up to a further 15 percent thanks to significant energy recuperation,” explains Schaeffler CTO Prof. Peter Gutzmer. “This entry-level hybridization is thus an economically attractive option that offers the essential advantages of a hybrid vehicle.” Automobile manufacturers who decide to install a second low-voltage on-board electric system (in addition to the standard 12 V system) can also integrate other suitable innovations into the vehicle. These include high-performance, rapid-reaction actuators that allow the roll stiffness or ground clearance to be regulated, which has a positive effect on factors such as the vehicle’s aerodynamics and thus on its fuel consumption.

Visitors taking a closer look at the Schaeffler innovations on display in Detroit will quickly understand why Schaeffler is one of the most in-demand suppliers of expertise to the automotive industry worldwide when it comes to efficient mobility today and in the future.

Images/Captions Schaeffler Efficient Future Mobility

The electric drive module paves the way for economical hybridization.



The trade show exhibit combines a range of ideas from Schaeffler that are suited to hybrid vehicles with high-performance low-voltage power systems, under the title 48 Volt.





The Schaeffler hybrid module 48 Volt allows drive and recuperation.



Schaeffler demonstration vehicle *Efficient Future Mobility North America*.

Images/Captions Schaeffler demonstration vehicle *Efficient Future Mobility North America*





Schaeffler's Concept Vehicle Displays Volume Production-Ready and Cost-Effective Solutions for the Optimization of Vehicles with Powertrains Based on Internal Combustion Engines

Custom-built for North America, suitable for the whole world

DETROIT/HERZOGENAURACH, January 13, 2014. Schaeffler offers a wide range of key technologies for reducing automobiles' fuel consumption and emissions, as well as for improving their energy efficiency. Many of these individual solutions only unveil their full potential when combined as part of a system, which Schaeffler is again highlighting with its current demonstration vehicle: *Efficient Future Mobility North America*.

This technology platform is based on the current version of a mid-size SUV that is popular in North America and features an automatic transmission with a torque converter. "The solutions on display take the market-specific demands and customer requirements in North America into account," explains Prof. Peter Gutzmer, CTO of Schaeffler AG.

The use and optimization of a range of Schaeffler technologies as well as painstakingly detailed work has allowed the vehicle's fuel consumption to be reduced by 15 percent, which means a corresponding drop in CO₂ emissions. These values were initially simulated using Schaeffler calculation programs and verified by Schaeffler's experts in North America using extensive measurements and test cycles, and then certified by an independent testing institute. What is remarkable here is that the Schaeffler technologies that are employed in this demonstration vehicle allow automobiles in the same category to achieve the limit values specified by the CAFE standard for 2020 with no additional electrification of the powertrain. (CAFE stands for *Corporate Average Fuel Economy* and defines the legal regulations for "fleet consumption" with regard to the targets set for 2020 and 2025, which even in North America are becoming increasingly restrictive.)

The concept vehicle employs Schaeffler systems such as a thermal management module and all-wheel drive (AWD) disconnect clutch. Other solutions that are on board include Schaeffler innovations for engine start-stop systems such as the "permanently engaged starter generator" with a wrap-spring one-way clutch and a latching valve that allows the vehicle to be driven for longer with the engine switched off without the need for energy-consuming pumps. Decisive contributions towards the impressive results were also made by the detailed friction optimization work carried out on the belt drive, the valve train and the balancer shafts, as well as the optimization of the torque converter.

Products like the new AWD disconnect clutch, which decouples the unused drive axle from the powertrain depending on the driving situation and thus makes a savings contribution of up to six percent (on the highway, for example) demonstrate the significant potential for reducing CO₂ emissions that is still offered by the powertrain. However, it is in city traffic that the “permanently engaged starter generator” with a wrap-spring one-way clutch really demonstrates its capabilities. In addition to a considerable increase in comfort in so-called “change of mind” situations (in which the engine is already switched off but the driver then quickly decides to drive on), this engine start-stop component allows fuel consumption to be reduced by up to six percent in city traffic. Fuel consumption can be lowered by an additional one percent through the integration of a thermal management module, which allows the optimum engine operating temperature to be reached in the shortest time possible and the temperature balance, which also includes other assemblies like the transmission and hybrid elements, to be precisely controlled.

The Schaeffler demonstration vehicle, which was constructed in North America, shows how future CAFE requirements can be met using cost-effective technology that is ready for volume-production.

“The optimization of powertrains based on internal combustion engines allows even vehicles of this size to achieve the values specified by the CAFE standard for the year 2020,” explains Jeff Hemphill, vice president and chief technical officer of Schaeffler North America. “But that’s not all: Our ideas for the electrification of the powertrain also put Schaeffler in a position to give the automotive industry the solutions it needs to fulfill the requirements set out for 2025.”

Images/Captions Schaeffler demonstration vehicle *Efficient Future Mobility North America*



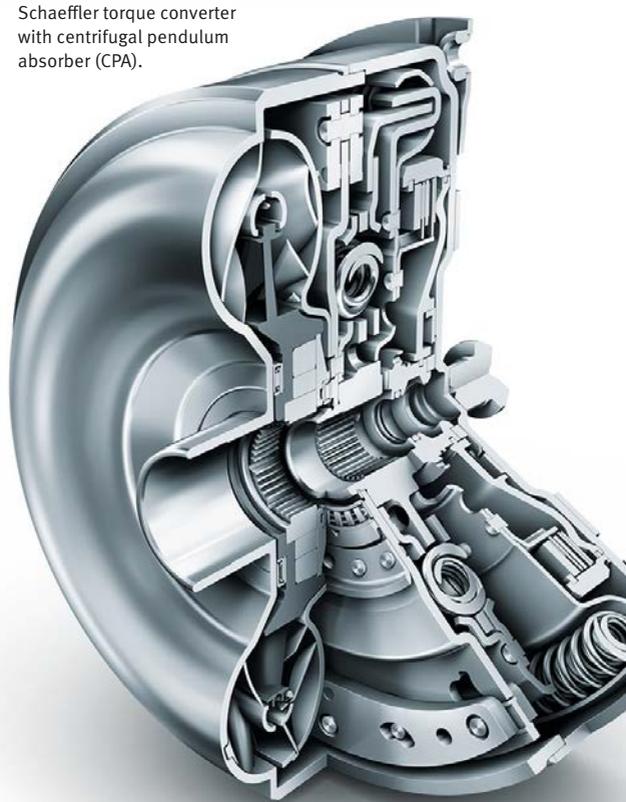
Schaeffler torque converter with centrifugal pendulum absorber (CPA).



Schaeffler permanently engaged starter generator (PES) with torque converter.



Schaeffler all-wheel drive disconnect clutch (AWD).



Schaeffler torque converter with centrifugal pendulum absorber (CPA).



Schaeffler latching valve.



Increasingly stringent CAFE standards make thinking in the long term a must

CAFE is becoming synonymous with environmentally friendly automobiles

DETROIT/HERZOGENAURACH, January 13, 2014. In 2009, the USA's limit values specified for passenger cars and light commercial vehicles were already made more stringent. Since then, additional regulations on fuel consumption (corporate average fuel economy (CAFE) standards) and the reduction of CO₂ emissions (greenhouse gas standards) have also been developed and ratified. The CAFE standards apply to vehicles from model year 2011 onwards and the greenhouse gas standards from model year 2012 onwards, and vehicle fleets in the USA are separated into passenger cars and light commercial vehicles. Up to model year 2016, average values of 140 grams of CO₂ per kilometer (225 grams per mile) and 188 grams of CO₂ per kilometer (302 grams per mile) have been specified for passenger cars and light commercial vehicles, respectively. From model year 2016 onwards, manufacturers have to achieve an average fuel consumption of 6.6 liters per 100 kilometers (35.5 miles per gallon) and a CO₂ emission value of 155 grams per kilometer (250 grams per mile) for passenger cars and light commercial vehicles combined. Categorization for these target values takes place using a so-called footprint, which is calculated by multiplying the length of the wheelbase by the track width. The CAFE limit values become more and more stringent every year and demand the highest annual reduction in fuel consumption of any region in the world (five percent each year). A global comparison shows the average adjustment value worldwide to be around four percent. The absolute value within the European Union is 130 grams by 2015, with a further reduction in CO₂ emissions to 95 grams (the lowest value worldwide) stipulated by 2020. All the same, vehicle fleets in Europe are compared in terms of vehicle weight as opposed to vehicle footprint.

This means that automobile manufacturers around the world are facing major challenges. Until now, competition in North America has mostly been defined by the performance, size and comfort that vehicles have to offer – an environment in which energy-efficient technological innovations were only a minor point of orientation. However, rising fuel costs, emissions regulations, and the CAFE standards are changing the situation in North America, and with it the focus for automobile manufacturers who, even in North America, are relying on innovative and efficient technologies.

Schaeffler, the globally oriented automotive and industrial supplier, is displaying a groundbreaking solution for the American automobile market with its *Efficient Future Mobility North America* concept vehicle at the 2014 NAIAS (North American International Auto Show). By carrying out extensive detailed work on various subsystems in the vehicle, experts at Schaeffler’s three North American research and development centers in Fort Mill, S.C. Troy, Mich. and Wooster, Ohio, were able to optimize the mid-size SUV in such a way that it now boasts 15 percent less fuel consumption and, even today, already achieves the values specified for this vehicle size by the CAFE standard for the year 2020 in a cost-effective way.

“Progress is never-ending. And that means the vehicle platform we have chosen still has further potential for optimization, despite already being efficient to begin with. The solutions that we have integrated take the market-specific requirements and customer demands in North America into account,” explains Philip George, director of Advanced Development at Schaeffler North America.



Schaeffler demonstration vehicle *Efficient Future Mobility North America*.

Images/Captions Schaeffler Efficient Future Mobility North America

EFFICIENT FUTURE MOBILITY NORTH AMERICA

Schaeffler's demonstration vehicle features tailored solutions for the North American market to optimize internal combustion engine drive trains. All of the technologies make a valuable contribution to reducing fuel consumption. The overall potential for savings is up to 15 percent.




Thermal Management Module

It allows the optimum engine temperature to be reached in the shortest time possible and the temperature balance, into which components such as transmissions and hybrid elements are also integrated, to be precisely controlled.



Fuel reduction in %		City	Highway
Technology:			
Belt Drive Friction Optimization		1.0	1.0
Valvetrain Friction Optimization		0.5	0.5
Balance Shaft Bearings		0.6	1.0
Thermal Management Module		1.0	1.0
Adaptive Grill Shutters		0.2	0.8
Engine-Start-Stop		6.0	2.0
AWD Disconnect		2.0	6.0
Wheel Bearings Optimization		0.5	1.0
TC with Centrifugal Pendulum-type Absorber		3.0	1.0
Total:		15	14

AWD Disconnect Clutch

It decouples the unused drive axle from the drive train – depending on the driving situation – providing a fuel saving contribution of up to six percent (on the highway).



Permanently Engaged Starter

In addition to a considerable increase in comfort created by the engine start-stop function and a significant improvement in so-called "change of mind" situations, this innovation helps to achieve fuel savings of up to six percent in city traffic.

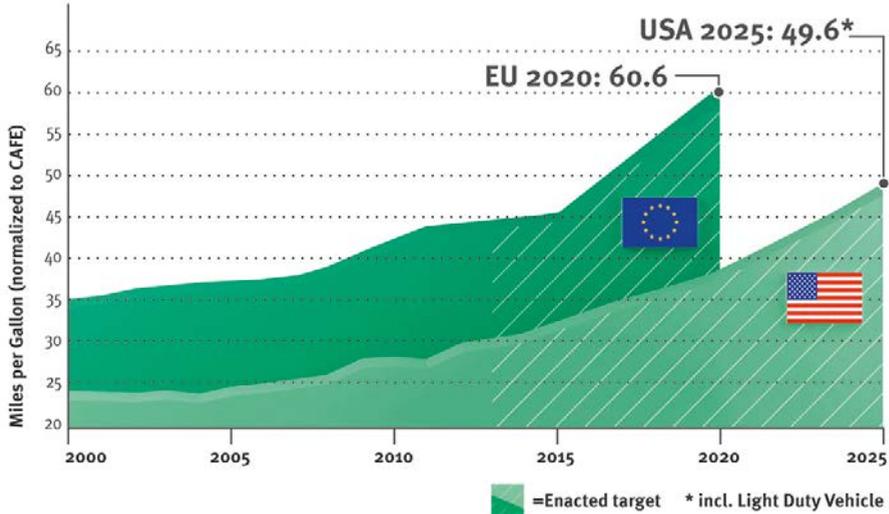


Latching Valve

Stores hydraulic pressure and provides automatic vehicles with energy for a faster start-up after the engine has been stopped.

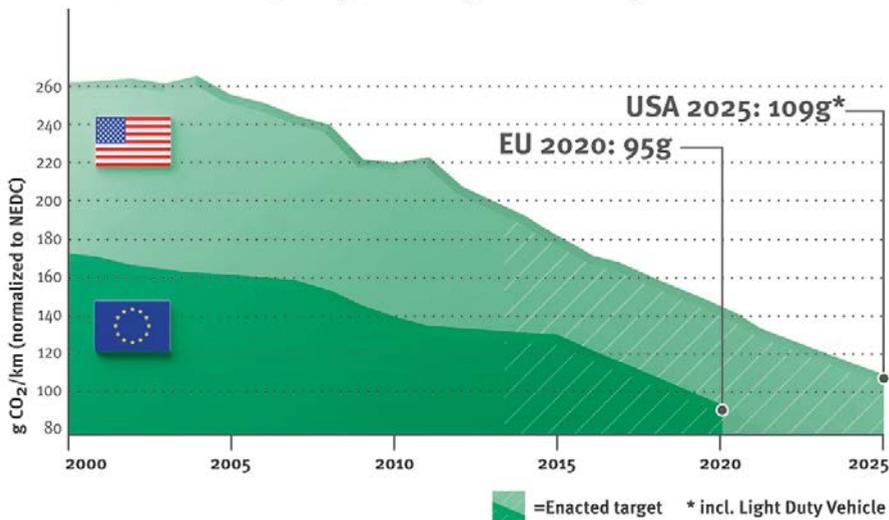


U.S. and EU CO₂ Regulatory Landscape



Source: ICCT 8/2013

U.S. and EU CO₂ Regulatory Landscape



Source: ICCT 8/2013

Innovations for Torque Converters Offer Significant Advantages
with Regard to Energy Efficiency, Design Envelope, Weight and Performance

Integrated torque converters – performance and efficiency with low space requirements

DETROIT/HERZOGENAURACH, January 13, 2014. Most new vehicles registered in North America are equipped with an automatic transmission with a torque converter. This is an area in which Schaeffler has been making a decisive contribution towards reducing fuel consumption and thus CO₂ emissions for decades with its innovations. These automatic transmissions, which were once branded inefficient, have been trimmed to exemplary levels of efficiency through continuous development work, so modern automatic transmissions with torque converters are no longer inferior to manual transmissions or double clutch systems when it comes to energy efficiency.

Torque converters have been primarily used in automatic transmissions and continuously variable transmissions for years. The converter is placed between the engine and the transmission, and transfers the engine torque to the transmission's input shaft. This transfer takes place hydrodynamically during startup and via an integrated friction clutch to reduce fuel consumption during driving operation. The converter additionally increases the torque on the transmission input shaft by up to a factor of three during startup.

“The desire for greater driving performance, reduced fuel consumption and lower emissions, as well as the increasingly compact design envelope, mean that the design and conception of modern torque converters have to be subject to continuous development,” explains Marc McGrath, president Transmission Systems at Schaeffler North America.

Higher performance with a lighter and more compact design

A glimpse of the new W238 generation of torque converters clearly shows the progress that has been made in development. This current generation boasts the following key data: 530 Nm of torque and a hydraulic diameter of 238 millimeters. This is now combined with a weight of just 14 kilograms and a hydraulic element width of around 50 mm. The previous W258 generation still weighed over 17 kilograms with a diameter of 258 mm and was 70 mm wide. More compact, more lightweight, but still delivering higher performance – the comparison of the two generations makes a clear point.

Schaeffler has been strengthening its position in the USA with its own torque converter development and manufacturing location in Wooster, Ohio since 1998. Wooster plays the role of a competence center in Schaeffler's global development network, which encompasses 40 locations and about 6,000 engineers and technicians. An important factor for the market success of LuK's torque converters is their continuous further development. Our development expertise means we are always making significant technological advances, including innovative damping concepts like the centrifugal pendulum-type absorber (CPA) and new converter concepts like the integrated torque converter and the multi-functional torque converter. There are multiple approaches for further reducing weight, mass inertia and costs.

Innovative converter concepts

The integrated torque converter is a completely revised converter and clutch system in which the clutch function is carried out directly by the torque converter turbine instead of using a separate piston, as was previously the case. This reduces the weight and mass moment of inertia while making the design envelope smaller and making it possible to implement innovative damping concepts like the CPA without needing any additional space. Centrifugal pendulum-type absorbers have been successfully used in rear-wheel drive vehicles since 2010. The combination of an integrated torque converter and CPA means they will also become increasingly widespread in front-wheel drive vehicles.

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

“The damper with a centrifugal pendulum-type absorber in the torque converter significantly improves the isolation of vibrations. This technology makes it possible to close the lockup clutch earlier and thus to simultaneously improve fuel economy and comfort,” explains Uwe Wagner, vice president Research and Development Automotive at Schaeffler. “This means that the CPA will be finding more widespread use in the torque converters of automatic transmissions in the future. And we will continue to further develop this technology in order to ensure that we maintain our competitive edge.”

The CPA is a finalist for the *Automotive News* PACE Award, which is presented annually in recognition of innovations in the automotive sector.

There is further converter innovation that is customized to suit modern, turbo-charged engines and represents a revolutionary invention in the field of converters: “The multi-functional torque converter, or MFTC, is ideal for use in combination with start–stop systems and can compensate for the delayed response – known as “turbo lag” – that is commonly experienced,” explains McGrath.

Furthermore, fuel savings of up to five percent can be achieved with the multi-functional torque converter, the optional idle disconnect function, and early torque converter lockup. The MFTC eliminates converter idling losses because the transmission can be decoupled from the engine, and this arrangement also allows the mass moments of inertia to be distributed in a more beneficial way – the result is outstanding isolation of vibrations in all operating ranges. Because of this decoupling, the engine reaches higher starting speeds at the moment at which the torque converter is activated, which in turn significantly improves the starting performance of turbocharged vehicles and is a way to avoid the dreaded “turbo lag.”

Increasing market share for automation

In 10 years time, it is probable that more than 100 million vehicles per year will be produced worldwide and more than half of those will be equipped with automatic transmissions. Automatic transmissions with torque converters will make up the majority of this number at around 30 million. In other words, the volume of automatic transmissions with torque converters on the market is set to rise by 13 percent during this period. However, torque converters are also installed as a startup element in continuously variable transmissions. The number of CVTs is set to rise to 12 million (an increase of approximately 70 percent), thus probably surpassing that of double clutch transmissions – which during the same period will increase roughly threefold. Growth for these transmissions is mainly being generated in Europe and China.

“Legal boundary conditions mean that the trend towards automatic transmissions may well become stronger in the future because measures for further reducing emissions and fuel consumption are difficult to implement with manual transmissions,” explains Andreas Englisch, vice president Product Unit CVT and Converters at Schaeffler.

The chronology of torque converters at Schaeffler

1983	LuK produces the first dampers for automatic transmissions (customer: Ford).
1990	LuK begins developing torque converters.
1997	LuK begins volume production of the Allison torque converter.
1998	LuK begins complete in-house production of torque converters (customer: GM).
2001	Volume production of torque converters for GM begins in Wooster (USA).
2004	Volume production of the Ford 6R torque converter – used in the USA’s top-selling vehicle (the F150) – begins in Wooster (USA).
2004	Volume production of ZF torque converters begins in Bühl (Germany).
2004	LuK produces its one millionth torque converter.
2005	LuK produces 1 million torque converters per year.
2010	Volume production of torque converter dampers with CPA (centrifugal pendulum-type absorbers) begins in Europe.
2012	LuK produces 2.1 million torque converters and an additional 2.3 million lockup clutches/dampers per year worldwide.
2013	Volume production of torque converters with CPA in Wooster (USA).
2014	Torque converter production begins in Taicang, China.

Images/Captions Schaeffler Torque Converter



Schaeffler torque converter with centrifugal pendulum absorber (CPA).



Schaeffler torque converter with centrifugal pendulum absorber (CPA).





Schaeffler demonstration vehicle *Efficient Future Mobility North America*.

48 V System – Schaeffler Presents Innovations for Entry-Level Hybridization with 48 Volts

Smart Hybridization with a 48 V Low-Voltage System

DETROIT/HERZOGENAURACH, January 13, 2014. Schaeffler has a wide range of ideas for future vehicles equipped with a high-performance 48-volt on-board electric system, and these are bundled together in the company's transparent vehicle trade show exhibit with technical solutions for 48-volt electrification on display at the North American International Auto Show (NAIAS) in Detroit, USA. This approach represents a smart and cost-effective solution for achieving specified fuel consumption and emissions targets in the future, such as those laid out for the year 2025 by the CAFE standard.

The central element is a compact 48-volt electric drive module that includes a clutch and planetary transmission, and can be placed either on the front or rear axle. This drive module paves the way for economical hybridization. The low-voltage design of the solution reduces the costs and outlay compared to high-voltage solutions with their associated requirements. This hybridization allows significant advances to be made in terms of drive efficiency, as the 48-volt electric system opens up operational possibilities that were previously the exclusive domain of vehicles with high-voltage hybrid components. Even with a 48-volt system, a significant level of energy recuperation can be achieved, i.e. a high proportion of the energy released when the vehicle decelerates can be recovered and fed back into the battery. This recovered energy can be used for the supplementary electric drive, which in turn directly reduces the vehicle's fuel consumption. In addition to energy recovery, the generator with an output of up to 12 kW can also be used to drive the vehicle. This provides options including so-called "crawling" – electrically powered driving in dense inner-city traffic, as well as moving off, driving at low speeds, and parking using electric power. Electric "boosting" during starting and so-called electric sailing – a driving mode in which the electric motor ensures constant speed while the internal combustion engine is switched off – make a positive contribution in terms of fuel consumption and emissions, however.

"Using a 48-volt solution makes it possible to achieve outputs of up to 12 kilowatts," summarizes Schaeffler CTO Prof. Peter Gutzmer. "This entry-level form of hybridization already offers the essential advantages of a hybrid vehicle and, at the same time, is an economically attractive, low-cost option that allows CO₂ emissions to be reduced by up to 15 percent."

The electric drive, which has an output of up to 12 kilowatts, acts as the hybrid vehicle's sole source of power when "crawling", i.e. in stop-and-go traffic. The electrically generated propulsion of Schaeffler's 48-volt drive module is also sufficient for driving in residential areas, parking garages, and other low-speed driving situations. This is also true of the comfortable driving mode known as "sailing", in which the electric motor ensures virtually constant speed across a wide operating range while the internal combustion engine is switched off. The electric drive assists the internal combustion engine by providing additional torque, e.g. when moving off from the traffic lights – a function referred to as "boosting". The high performance of the 48-volt system also means that the drive element opens up new potential for energy recovery. Due to the higher recovery capability, the kinetic energy released during deceleration is now no longer converted into heat that subsequently dissipates, but is instead fed back into the on-board electric system in the form of electrical energy. The choice of two gear stages for the Schaeffler drive also provides further benefits when it comes to regenerative braking.

"The fact that the drive unit is connected directly to the propshaft in vehicles with rear-wheel drive means that drag losses by the internal combustion engine are prevented. We can thus achieve maximum efficiency and make driving situations possible that were previously only offered by hybrid vehicles with significantly more complex designs," explains Dr. Tomas Smetana, vice president Product Group Electric Axle Systems at Schaeffler. "Our combination of an electric motor and transmission also allows the flow of force to be distributed selectively, drive torques can be superimposed, and even torque vectoring – the variable distribution of torque that serves to increase driving safety – is possible."

The compact design of the cylindrical drive module means that it can easily be integrated into the powertrain, so it can be integrated into the architecture of the vehicle without having to reduce the volume of the trunk or the fuel tank.

Automobile manufacturers who decide to install a second low-voltage on-board electric system (48 volts in addition to the standard 12-volt system) can also integrate other suitable innovations into the vehicle. These include high-performance, rapid-reaction actuators for the chassis that allow the ground clearance to be regulated according to the situation during driving, which has a positive affect on the vehicle's aerodynamics and thus on its fuel consumption. In addition to the high performance due to the higher voltage range, the second on-board electric system also offers the advantage of smaller cable cross-sections. This saves weight and facilitates the integration and installation of the wire harnesses in the vehicle.

A range of other functions that push today’s standard 12-volt systems to the limit of their performance can be practically integrated into the architecture of a 48-volt system. These range from mechanical tensioning elements for 48-volt belt-driven starter generators and a number of electromechanical adjusting elements for the clutch, steering, roll stabilization and self-leveling suspension through to hybrid modules, axle drive solutions, and electromechanical torque vectoring units.

“We have combined a large number of conceivable products together in this trade show exhibit,” explains Gutzmer. “Our aim is to show the wide range of possible solutions and demonstrate Schaeffler’s system-based approach.”



The electric drive module paves the way for economical hybridization.



The Schaeffler hybrid module 48 Volt allows drive and recuperation.



Images/Captions 48 V / Hybridization

SMART HYBRIDIZATION WITH 48 V

The increasing electrification of the drive train compensates for the intrinsic weaknesses of the internal combustion engine and utilizes additional potential for efficiency. Innovative products for a second, low-voltage on-board electric system with 48 volts (in addition to the existing 12-volt system) provide advantages that were previously only offered by expensive hybrid vehicles.

48 V electric motor
12 V battery
48 V lithium ion battery

SCHAEFFLER
LUK INA FAG

Increased Performance through Downsizing of the Electrical Architecture

Cable thickness	Max. power
12 V	3 kW
48 V	12 kW

Increasing the voltage to 48 V not only makes it possible to raise the power limit to a total of 12 kW (i.e. a fourfold increase), it also allows the conductor cross-section to be reduced by 75% at the same time. This has a positive effect on the weight, cost, and design envelope of the cable harness.

New Possibilities with 48 V Electric Drives

The 48 V electric motor has an output of up to 12 kW and makes new functions possible, such as allowing the vehicle to **move off solely using electric power** and to "sail". When the vehicle is "sailing", the electric motor uses an additional operating range to ensure that the speed remains constant even while the internal combustion engine is switched off.

Boosting with Braking Energy

A 48 V on-board electric system allows efficient recuperation, i.e. recovery and storage of energy during braking. The energy that is recovered can be used for "boosting", e.g. to assist the internal combustion engine during overtaking maneuvers.

Brake
BOOSTING
BRAKING
48 V battery

RECOVERY OF BRAKING ENERGY

Up to now, braking energy was lost in the form of heat. Modern hybrid components enable the recovery of braking energy (recuperation). The performance of the components in electrified drive trains is a decisive factor. A low-voltage power system with 48 volts allows energy flows in the order of up to 12 kW – and is sufficient for significant, fuel consumption-reducing energy recovery.

12V **48V** **High voltage**

What is the New European Driving Cycle?

The consumption and CO₂ emissions of vehicles are determined with the **New European Driving Cycle (NEDC)**. This standardized driving program simulates a comparable, everyday driving profile. The diagram shows that energy flows less than 12 kW occur during most braking and a 48-volt system enables efficient recuperation.

125
100
75
50
25
0

125
100
75
50
25
0

Km/h **Time (s)**

12-kW limit

theoretical recuperation potential

Electric motor
Internal combustion engine
Brake

Recuperation capacity depending on voltage of electric system

An increase in voltage from 12 V to 48 V significantly increases the recuperation capacity. Slightly more braking energy can only be converted into electrical energy with a high-voltage system.

- Energy recovery
- Unused braking energy due to losses
- Road resistance

Schaeffler Automotive

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

DETROIT/HERZOGENAURACH, January 13, 2014. Schaeffler is a renowned supplier to the automotive industry worldwide. Around 70 percent of Schaeffler's sales volume comes from its Automotive division. Schaeffler's reputation as a supplier to the automotive industry stems from a range of innovative components, modules and systems for engine, transmission and chassis applications. The company's portfolio ranges from the optimization of powertrains based on internal combustion engines and solutions for the electrification of the powertrain through to hybridization and all-electric mobility. 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 of minimizing fuel consumption and emissions.

UniAir, camshaft phasing units, belt drive systems and overrunning alternator pulleys, lightweight differentials with face splines, dual mass flywheels, centrifugal pendulum-type absorbers, torque converters and lightweight balancer shafts, essential components for manual, continuously variable, and automatic transmissions, double clutch systems, TwinTandem bearings, wheel bearings with face splines, and components for hybrid vehicles and electric mobility – Schaeffler's portfolio is expansive and varied.

As well as reducing fuel consumption and emissions, Schaeffler's innovations make an important contribution to increasing safety and driving pleasure. Chassis, steering and transmission components are of particular significance here. 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 in Schaeffler's genes.

Close, trusting cooperation with renowned automobile manufacturers has a long tradition at Schaeffler and is the source of continuous innovations that have been established in the market in cooperation with numerous manufacturers.

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

Images/Captions Schaeffler Automotive



One of the Schaeffler locations in North America is the research and development center in Troy, just outside Detroit. It is one of 40 Schaeffler R&D centers worldwide.

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

SCHAEFFLER

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