



# TECHNOLOGIES FOR CARS

Systems expertise down to the last detail



**SCHAEFFLER**



## ENGINEERING AND MANUFACTURING – AT THE CUSTOMER’S SIDE, EVERYWHERE IN THE WORLD

Being close to our customers is one of Schaeffler’s hallmarks. Our 180 locations around the world ensure that we are precisely where our customers need us – nearby. Our engineering, production and maintenance services provide a local presence and a local commitment to each region. Together with our customers, we develop solutions on site that fulfill the specific needs of the different markets. Our manufacturing locations enable us to provide smoothly-organized delivery due to our rapid response times and service right at the customer’s doorstep.

Regardless of whether replacement parts are required quickly for passenger cars, trucks or tractors or whether a workshop needs support - our Automotive Aftermarket business division is responsible for automotive replacement parts and service. Schaeffler’s Aftermarket specialists deliver innovative repair solutions, initiate service concepts, and provide optimum benefits through the transfer of expertise and practical training for workshops and distributors.

## PARTNER OF THE AUTOMOTIVE INDUSTRY

As a partner of the automotive industry, we are the leaders in the development and production of solutions to the demanding challenges of the vehicles of the future. Together with our customers, we are already developing solutions for the mobility of tomorrow.

With the strong INA, LuK and FAG brands, Schaeffler develops and produces precision elements and systems for engines, transmissions and chassis. The broad spectrum of products comprises construction elements for vehicles with combustion engine-driven drive trains, hybrid vehicles and electric cars.

## What we stand for: Quality, Technology and Innovation

### Quality - precise and reliable

Through production expertise and comprehensive quality management, Schaeffler safeguards product quality that far exceeds the industry average. The benchmark is the zero-defect principle, which stabilizes processes and ensures constant improvement. Numerous accreditations from customers and certificates confirming compliance with internationally valid standards testify to the superb standard of quality. Schaeffler received 33 quality awards in 2014 including, for example, the “Supplier Quality Excellence Award” from GM.

### Technology - successful and pioneering

Schaeffler’s production system incorporates an exceptionally high degree of expertise and all of the state-of-the-art technologies needed to deliver excellent cost effectiveness and precision. With a high production depth, Schaeffler manufactures precision products in its 74 plants across the world. Schaeffler is one of the industry’s technology leaders in many areas of production, e.g. cold forming technology, forging or heat treatment, The company’s own special equipment construction facility supports the setup of assembly and production lines.

### Innovation - progressive and future-focused

Around 6,400 staff working at 16 R&D centers develop new products, technologies, processes and methods for market-ready solutions. With more than 2,500 patent registrations in 2014 and currently 23,000 active patents and patent applications, Schaeffler is the second most innovative company in Germany according to the German Patent and Brand Office, making it one of the industry’s leaders in terms of innovation.



## DEMONSTRATION OF INNOVATION AND SYSTEM UNDERSTANDING

Less consumption, fewer emissions. More power, comfort and safety. Our concept vehicles are bursting with innovative technology for combustion engines, hybrid vehicles and electromobility. To ensure the perfect interaction of our products, we combined our in-depth component expertise with a comprehensive understanding of systems. As a result, we always deliver the best possible package of products and services. Our concept vehicles are an expression of the results-orientated variety that Schaeffler uses to support its customers. After all, the future of mobility offers many possibilities.

## SYSTEM EXPERTISE DOWN TO THE FINEST DETAIL

Our system expertise, aimed at optimization of the drive train, hybridization and electrification, covers every last detail. The best example of this is Schaeffler's broad product portfolio, which comprises precision components and systems in the domains of engines, transmissions and chassis, as well as electromobility. The entire portfolio also meets the demands for reducing CO<sub>2</sub> emissions and fuel consumption, and here too we offer our customers the best possible support.



### Engine systems

Rolling bearing solutions, products for belt and chain drives, valve drive components and systems for variable valve drives



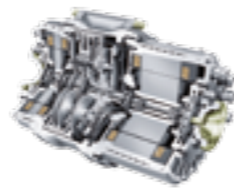
### Transmission systems

Torsional vibration dampers, clutches and double clutch systems, torque converters, CVT elements, lightweight differentials, bearing solutions, synchronization and gear shift units



### Chassis systems

Wheel bearings, bearing solutions, steering components and electro-mechanical actuators for rolling stabilizers and power steering



### Hybrid and electrical drive systems

Hybrid modules, electrical axle drives, range extender transmissions, hydrostatic clutch actuators, electrical wheel hub drives



### Gasoline Technology Car (GTC) concept vehicle

Extensive potential savings thanks to highly integrated concept with technologies such as 48 Volt hybridization, the thermomanagement module, and clutch by wire.



### Schaeffler System 48 V concept vehicle

A 48 Volt hybridization allows an inexpensive entry into the efficient world of hybrid vehicles. Recuperation (energy recovery on deceleration) means significantly lower fuel consumption and therefore much fewer emissions.

### The Efficient Future Mobility concept vehicles exhibit technological solutions for regional requirements.



### Efficient Future Mobility North America

- Disconnectable all-wheel drive
- Permanently track-adjusted starter motor
- Level regulation



### Efficient Future Mobility India

- Electrical clutch management allows passive coasting



### Efficient Future Mobility China

- Plug-in hybrid with P2 module in combination with optimized downsizing combustion engine
- Dry double clutch

STANDARD VALVETRAINS



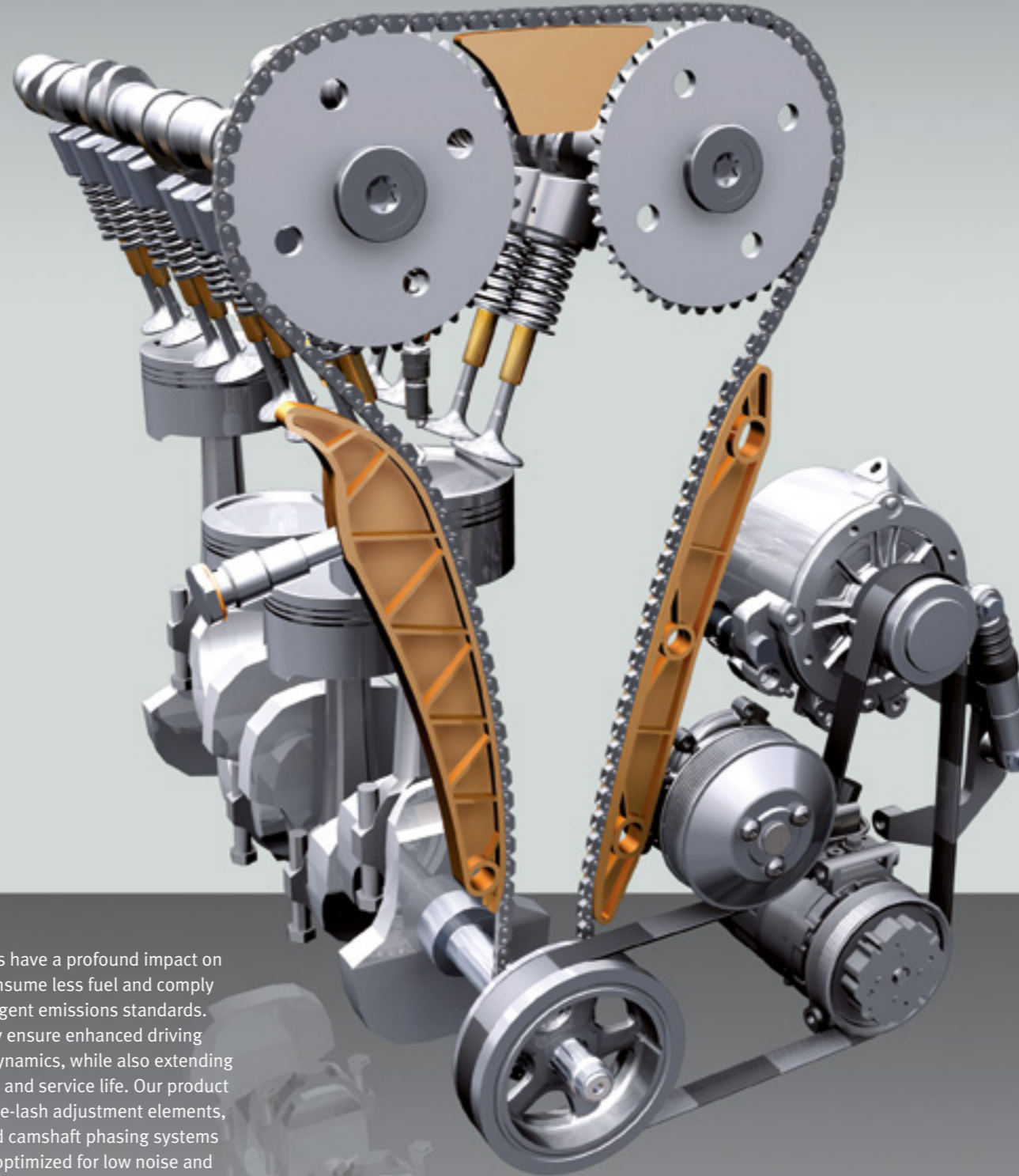
VARIABLE VALVETRAINS



CAMSHAFT PHASING SYSTEMS



# ENGINE COMPONENTS AND SYSTEMS

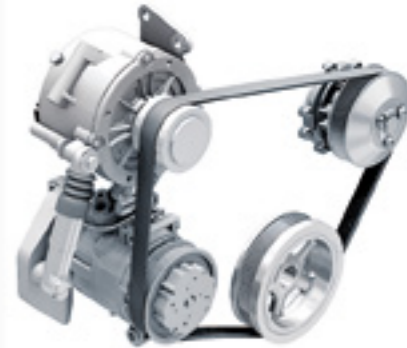


Our precision products have a profound impact on helping engines to consume less fuel and comply with increasingly stringent emissions standards. At the same time, they ensure enhanced driving comfort and vehicle dynamics, while also extending maintenance intervals and service life. Our product portfolio includes valve-lash adjustment elements, variable valvetrain and camshaft phasing systems chain and belt drives optimized for low noise and long service life, as well as rolling bearing supports for engine shafts.

CHAIN DRIVES



BELT DRIVES



ENGINE SHAFTS SUPPORTED BY ROLLING BEARINGS



## STANDARD VALVETRAINS



Mechanical Tappets · Hydraulic Tappets · Finger Followers · Rocker Arms · Cam Levers

### Maintenance-Free for Life

Components that are used for valve-lash adjustment enable precise valve lash and a low-friction valvetrain – maintenance-free for the entire life of the engine. Schaeffler Automotive develops and manufactures valve-lash adjustment components for engines with overhead camshafts (OHC) or overhead valves (OHV), for direct and indirect drive, as well as for hydraulic or mechanical lash adjustment.

## VARIABLE VALVETRAINS



Fully Variable Electro-Hydraulic Valve Control System UniAir · Cam Shifting Systems · Mechanical Switchable Tappets · Hydraulic Switchable Tappets · Switchable Finger Followers · Switchable Pivot Elements · Switchable Roller Tappets · Switchable Valves

### Maximum Efficiency

Switchable valvetrain components used for valve-lift adjustment and cylinder deactivation permit a variety of valve-lift curves and optimize the engine's torque characteristics and maximum power output. Depending on the type of engine, it is therefore possible to reduce fuel consumption and exhaust emissions while increasing power and torque. Cylinder deactivation is predominantly used in large-displacement engines and leads to significant improvements in fuel economy.

## CAMSHAFT PHASING SYSTEMS



Camshaft Phasing Units for Chain Drives · Hydraulic and electromechanical camshaft phasing units · Solenoid Valves

### Economical and Dynamic

Economical and Dynamic Camshaft phasing systems also make a significant contribution to reducing fuel consumption and emissions. They optimize valve timing across a wide range of engine loads and speeds, thereby increasing vehicle dynamics and driving pleasure. Belt- and chain-driven systems are available that can be used to adjust either a single camshaft, both camshafts synchronously, or both camshafts independently of each other. Lightweight camshaft phasing units are made from deep-drawn sheet metal.

## CHAIN DRIVES



Chain Drive Systems · Tooth, Roller and Sleeve Chains for Primary Drive Systems · Tensioner Blades and Chain Guides · Chain Tensioners (Main Drive) · Camshaft-Drive Tensioners (Auxiliary Drives)

### Precision and Reliability

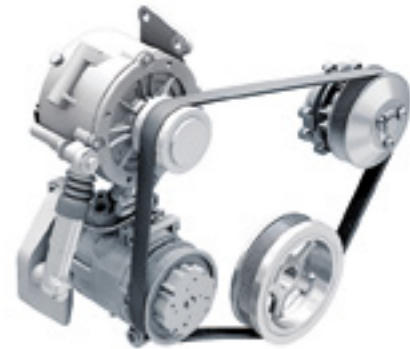
Schaeffler is the only company in the world with a complete range of chains for automotive applications that encompasses all types of engine timing chains, tensioned chains for continuously-variable automatic transmissions and drive chains for transfer cases and differentials. Schaeffler also develops and manufactures all ancillary components for chain drives, such as chain tensioners, chain guides and chain sprockets.

Belt Drive Systems · Primary Drives · Toothed-Belt Tensioners for Primary Drives · Toothed Chains in the Primary Drive · Auxiliary Drives · Mechanically-Dampened Belt Tensioners · Hydraulically-Dampened Belt Tensioners · Belt-Driven Starter Generator Drives (RSG) · Tensioning Systems for Belt-Driven Starter Generators · Tensioner and Idler Pulleys · Overrunning Alternator Pulleys (OAP) · Thermal Management Modules

### Smooth Running and Low Vibration

Belt drives are used for controlling engine timing and for driving accessories. As a systems supplier, we develop and manufacture tensioner and idler pulleys, hydraulic and mechanical belt-tensioning systems, as well as alternator decoupling devices. Operating absolutely maintenance-free, these systems are perfectly matched to each other and set the standard for durability. The belt-driven starter generator represents a highly effective approach to hybridizing the drivetrain. This device allows the engine to operate in a comfortable and efficient start/stop mode, thereby making a significant contribution toward reducing fuel consumption and emissions. The thermal management module is a key to energy-efficient engine temperature control.

## BELT DRIVES



Rolling Bearing Supports for Balancer Shafts · Lightweight Balancer Shafts · Rolling Bearing Supports for Camshafts · Rolling bearing supports for turbochargers

### Less Friction inside the Engine

Schaeffler Automotive develops innovative solutions for rolling bearing supports in crankshafts, camshafts and balancer shafts that offer considerable potential for reducing power losses in the engine, and, therefore, improved fuel economy and lower emissions. Balancer shafts with rolling bearing supports, for example, generate approximately 50 % less friction compared with shafts supported by plain bearings. Schaeffler has also succeeded in developing an optimized design for balancer shafts that is up to 40 % lighter with no performance losses.

## ENGINE SHAFTS SUPPORTED BY ROLLING BEARINGS



BEARING SUPPORTS  
FOR TRANSMISSIONS  
AND REAR AXLE DRIVES



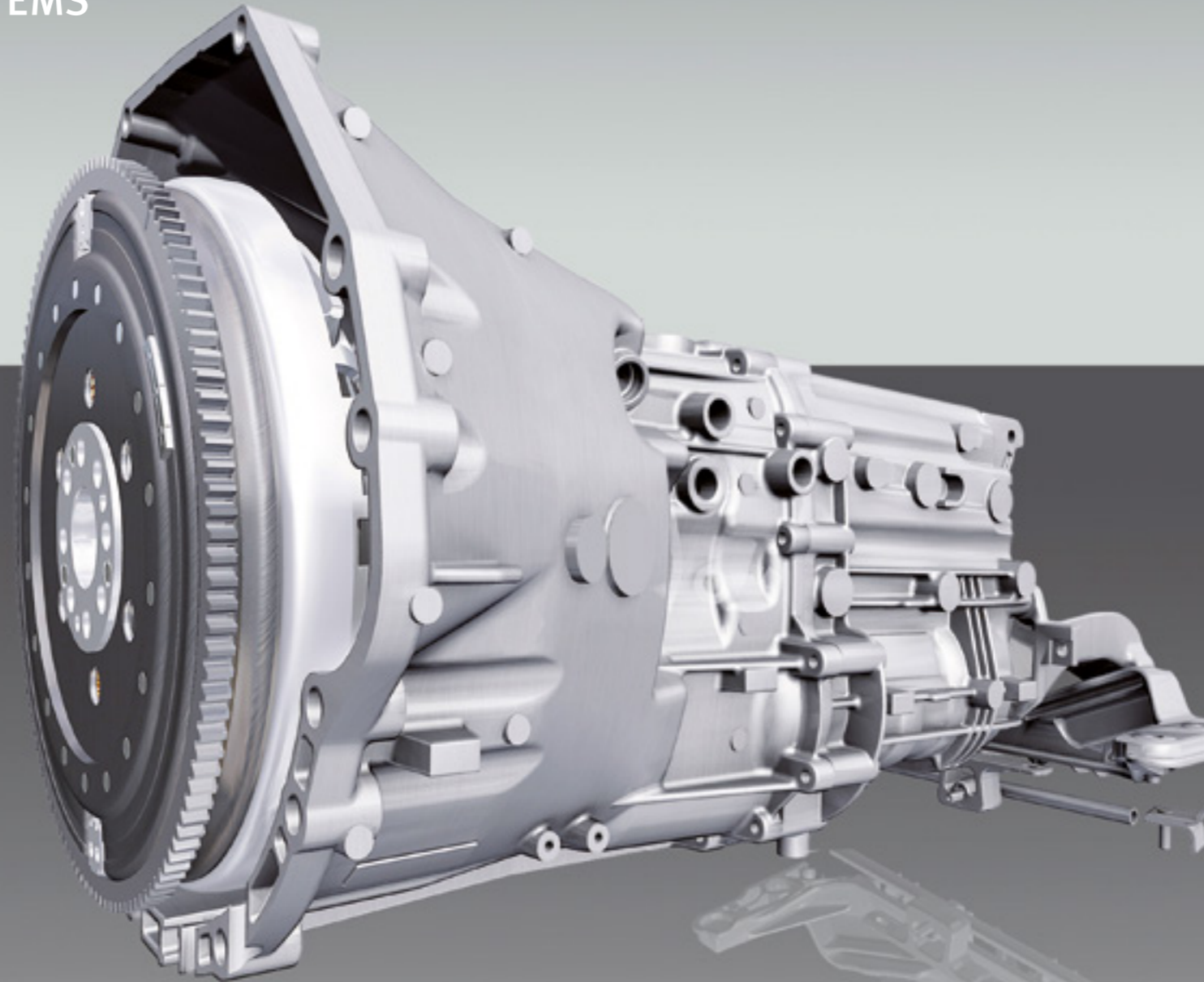
LIGHTWEIGHT DIFFERENTIALS



CLUTCHES/SHIFT SYSTEMS/  
SYNCHRONIZERS



## TRANSMISSION COMPONENTS AND SYSTEMS



Recent years have seen the development of several new types of transmissions that have already made it into volume production. Automated manual transmissions, double-clutch transmissions and CVTs have joined the “classic” manual and automatic transmissions. Applications designed for alternative drive systems, such as hybrid drivetrains, round off the spectrum of future transmission designs. With its innovative components and systems, Schaeffler Automotive is significantly advancing the development of all types of designs and concepts in pursuit of increased driving comfort and reduced fuel consumption.

SOLUTIONS FOR DOUBLE-  
CLUTCH AND AUTOMATED  
TRANSMISSIONS



SOLUTIONS FOR AUTOMATIC  
TRANSMISSIONS



TORSIONAL VIBRATION  
DAMPERS



BEARING SUPPORTS  
FOR TRANSMISSIONS  
AND REAR AXLE DRIVES



Needle Roller Bearings · Ball Bearings · Tapered Roller Bearings · Drawn Cup Roller Bearings · Planetary Gear Sets · Angular Contact Ball Bearings · Tandem Angular Contact Ball Bearings

**A Systematic Approach**

Schaeffler Automotive offers system solutions for all the bearings used in a transmission system – space-saving, low-friction and capable of handling high loads. This also includes solutions for radial and axial bearing supports of transmission shafts and gears, as well as complete planetary gear sets. When devising solutions, we look beyond the individual bearing, as we understand and consider the entire system. Conventional tapered roller bearings are being replaced by tandem angular contact ball bearings with two different pitch circles that are designed to support pinions and differentials in the front and rear axle drives. Less friction, and therefore reduced heat buildup, results in significantly higher efficiency which in turn leads to improved fuel economy. This allows modern cars to lower exhaust emissions and consume less fuel, while extending the service life of the individual components.

LIGHTWEIGHT DIFFERENTIALS



Lightweight Differentials

**Weight reduction and more space**

More compact, lighter, quieter, more efficient and even higher performance – these are the attributes of the innovative lightweight differential. The completely new architecture of this component allows the installation space to be reduced by 70 %. The lightweight differential has spur gears arranged as a planetary gear set in one plane, which results in 30 % lower weight compared with the conventional design. The lightweight differential is also a key component for innovative solutions in electric mobility, such as the eDifferential.

CLUTCHES/SHIFT SYSTEMS/  
SYNCHRONIZERS



Clutches · Clutch Discs · Clutch Release Systems/Clutch Release Bearings · Peak Torque Limiters · Clutch-Servo Assistance · Linings · Shift Systems · Gearshift Units/Gearshift Domes · Pendulum-type absorbers for clutches · Drawn Cup Needle Roller Bearing for Linear and Rotary Motion · Shift Detents · Gearshift Sleeves · Intermediate Rings for Synchronizers ·

**Shifting with Feeling**

In manual transmissions, our components for clutches, shifters and synchronizers ensure quick, secure and precise gear changes. Our clutch-release systems and self-adjusting clutches require very little force to operate and feature automatic wear compensation. Gearshift and synchronization components deliver smooth shifts – from long and comfortable to short and sporty. Early on in the design process, our simulation technology developed in-house enables us to preview the actual shifting characteristics, so that the “feel” of the shift system matches the intended application.

Solutions for Automated Manual Transmissions · Solutions for Double-Clutch Transmissions (dry and wet) · Solutions for Hybridized Double-Clutch Transmissions

**Automated Solutions Come in Twos**

We are a vital partner of the automotive industry in the development of new transmission designs. Recent innovations include automated manual transmissions and double-clutch transmissions that offer comfortable operation and dynamic performance while reducing fuel consumption. A concept used in hybrid drives is the hybridized double-clutch transmission. By integrating an electric motor, all the hybrid features – such as the start/stop function, regenerative braking and the ability to downsize the combustion engine through a booster function – are available without adding extra components.

SOLUTIONS FOR DOUBLE-  
CLUTCH AND AUTOMATED  
TRANSMISSIONS



Pulley Sets for CVTs · Chains for CVTs · Torque Converters · Pendulum-type absorbers for torque converters · Torque Converter Lockup Clutches

**Enhanced Comfort through Automatic Transmissions**

In addition to supplying the complete set of bearings for shafts and gears as well as planetary gear sets, Schaeffler Automotive also offers components for automatic transmissions, especially torque converters and torque converter lockup clutches. With our components for continuously-variable transmissions (CVTs), such as pulley sets, link-plate chains and hydraulic components, we brought the first high-performance CVT to market in partnership with Audi. This can be used with powerful engines that generate up to 400 Nm of torque.

SOLUTIONS FOR AUTOMATIC  
TRANSMISSIONS



Dual Mass Flywheels and pendulum-type absorbers · Balancer Shaft Dampers · Crankshaft Dampers

**A Smooth-Running Drivetrain**

The dual mass flywheel makes it possible to enjoy a more comfortable driving experience while consuming less fuel, as it reduces the vibrations in the drivetrain. Among its many contributions, this innovation has had a profound impact on the success of the diesel engine. The innovative dual mass flywheel with centrifugal pendulum-type absorber is another key component for improved fuel economy and lower exhaust emissions, and it enables even higher driving comfort at the same time. Today, there are also components available that can dampen vibrations in the engine, such as dampers for crankshafts and balancer shafts.

TORSIONAL VIBRATION  
DAMPERS



BEARINGS FOR CHASSIS APPLICATIONS



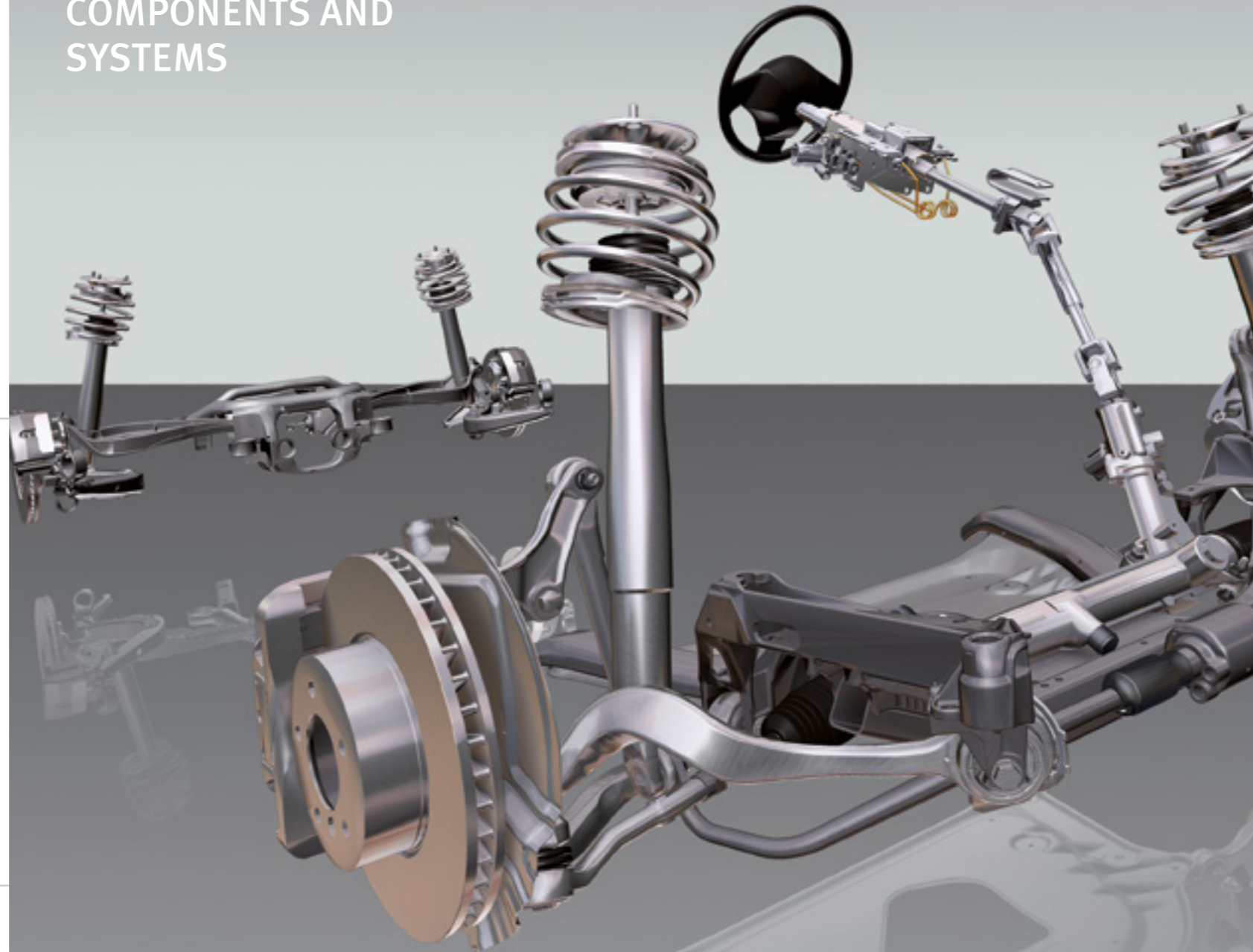
BEARINGS AND COMPONENTS FOR THE STEERING COLUMN



WHEEL BEARINGS



## CHASSIS AND ACCESSORY COMPONENTS AND SYSTEMS



Today, our solutions for chassis applications go far beyond mere bearings – we have reengineered them to the point that they are now complete mechatronic systems: with sophisticated technology ranging from integrated sensors for capturing data, to electromechanical actuators for active chassis applications. While our focus is on increased safety and comfort, our products also meet the demands for cost-effectiveness, compact dimensions, ease of installation and maintenance-free service life. Bearings for accessories and special applications for commercial vehicles round off our product portfolio.

ELECTROMECHANICAL ACTUATORS



APPLICATIONS FOR COMMERCIAL VEHICLES



BEARINGS FOR ACCESSORY DEVICES AND VEHICLE INTERIORS





## BEARINGS FOR CHASSIS APPLICATIONS



MacPherson Strut Bearings · Spring Seat Bearings · Universal Joint Bearings (IPH fitting method) · Tripod Rollers

### Sophisticated Solutions

Our bearing solutions for the chassis are fully engineered – from design through production to assembly. Our drawn and hardened universal joint bearings, for example are designed to transfer torques in steering shafts and driveshafts with zero backlash. Compared with conventionally-manufactured products, they offer significantly higher load carrying capacity. To optimize running smoothness, we have even developed a special assembly technique along with the corresponding machines.

## BEARINGS AND COMPONENTS FOR THE STEERING COLUMN



Steering Column Bearings · Clamping Devices · Linear Bearings/ Displacement Bearings · Power Steering Pump Bearings

### Precise and Comfortable Steering

The steering not only controls the vehicle's direction, but it also directly communicates driving "feel" and comfort to the driver, while also contributing significantly to driver safety. Here, the bearings inside the steering column play a crucial role. Our extensive R&D work on bearings and components for the steering column has resulted in greater protection for the driver in crash situations, improved steering comfort and reduced vibrations in the steering wheel.

## WHEEL BEARINGS



Wheel Bearings · Wheel Modules · Four-Row Angular Contact Ball Bearings (Twin Tandem)

### Innovative Wheel Bearing Solutions

Our solutions for maintenance-free wheel bearings range from compact bearing units to highly-integrated assemblies that incorporate the wheel carrier. Built-in sensors supply data used for the controlling of ABS, ESP, as well as active-chassis settings. Wheel forces can be measured continuously. For wheel bearings in vans, SUVs and light trucks, we have developed a special four-row angular contact ball bearing that can replace conventional tapered roller bearings and significantly reduces fuel consumption and emissions. The innovative wheel bearing with face spline offers capacity reserves in addition to weight reduction, optimized installation and longer service life.

Electromechanical Roll Stabilizers · Ball Screw Drives · Electromechanical Steering Systems · Ride-Height Leveling Systems · Track and Camber Adjustment

### Ingenious Technology for Active Chassis Applications

Our electrically-driven ball screw drive actuators can be used in numerous innovative automotive chassis applications, for example in electromechanical steering systems. Offering greater comfort, lower costs and reduced fuel consumption, these systems can replace the complex hydraulic power steering systems. Other application examples include electromechanical roll stabilizers and brakes, as well as active chassis-adjustment systems for ride-height leveling, or for track and camber adjustment.

## ELECTROMECHANICAL ACTUATORS



Kingpin Bearings · Stabilizer Bearings · Brake Adjusters · Half-Shells · Insert Bearings

### Safety and Durability

We also develop products that are specifically designed to meet the requirements of commercial-vehicle chassis. Our automatic adjuster unit for brakes used on commercial vehicles compensates for brake lining wear, thereby ensuring optimum braking performance. Kingpin bearings used in the steered axles in commercial vehicles can absorb radial and axial loads. They are maintenance-free and sealed to keep out moisture and dirt. Superior reliability and durability distinguish our range of wheel bearings that have been specifically developed for commercial vehicles; they deliver miles and miles of maintenance-free service.

## APPLICATIONS FOR COMMERCIAL VEHICLES



ABS Pump Bearings · Throttle-Valve Bearings · Turbocharger Bearings · Starter Motor Bearings · Air-Conditioning Compressor Bearings · Water Pump Bearings · Plain Bearings

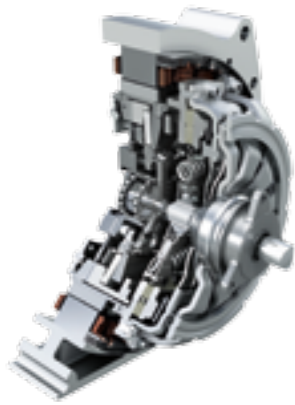
### Reliable under Extreme Conditions

Accessory devices in vehicles require specific bearings to ensure reliable operation. Whether in ABS pumps or water pumps, throttle valves or bearing supports in the air-conditioning compressor and starter – we have developed the right products for every application. Each is matched to the part's specific function and operating environment, thereby ensuring smooth and maintenance-free operation – even under extreme temperatures and dirty conditions, as well as in very tight spaces. We also offer individually-designed plastic-composite plain bearings that are used in the vehicle's interior, as well as in convertible tops, sunroofs and other automotive applications.

## BEARINGS FOR ACCESSORY DEVICES AND VEHICLE INTERIORS



#### HYBRID MODULES



#### ELECTRICAL AXLE DRIVES



#### ELECTRICAL WHEEL HUB DRIVES



## SYSTEMS FOR HYBRID AND ELECTRICAL DRIVE SYSTEMS

The consumption and emissions targets of the future can only be fully met through electrification of the drive train. As a result, Schaeffler offers solutions across the full bandwidth of electrification options - from 48 Volt hybrids and plug-in hybrids to purely electric vehicles. This broad spectrum of knowledge makes Schaeffler an expert partner to the various markets and customers it serves - such as with hybrid modules, electrical axle drives, range extender transmissions, hydrostatic clutch actuators and electrical wheel hub drives.

## MOBILITY FOR THE FUTURE



Globalization, urbanization, digitization, the scarcity of resources and the growing demand for affordable mobility is creating increasingly dynamic market demands. In light of these major trends, the Schaeffler Group has developed its cross-regional strategic concept entitled “Mobility for the Future” for the automotive and industry sectors.

Schaeffler is actively co-shaping the “Mobility for the Future” through its own research and development, providing its customers and business partners with an attractive portfolio of products. Environmentally-friendly drive technologies comprise a range of products designed to optimize the combustion engine-based drive train, as well as hybrid and electric vehicles. As the innovation and technology leader, the Schaeffler Group is making a crucial contribution to the mobility of the future.

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