**Audi launches next-gen A4 with new Millerized TFSI engine; g-tron model w/ Audi e-gas**

*29 June 2015*

Audi has [unveiled](https://www.audi-mediacenter.com/en/4328) the new-generation Audi A4 and A4 Avant, developed with a high priority on the reduction of CO2 emissions. Among other developments, the new A4 is the launch vehicle for the new high-efficiency 2.0L TFSI based on Miller cycle, introduced by Audi earlier this year at the Vienna Motor Symposium. ([Earlier post](http://www.greencarcongress.com/2015/05/20150708-audi.html).) The A4 Sedan and the A4 Avant will be launched in the market this fall.

The new models deliver CO2 emissions as low as 95 grams per kilometer (152.9 grams per mile) for the A4 Sedan 2.0 TDI ultra with 110 kW (150 hp). The new A4 Sedan has the best drag coefficient in its class at 0.23, while Avant has cd 0.26. Further, although compared with the previous model the car’s dimensions have grown, its weight has been reduced by up to 120 kilograms (265 lbs), depending on the engine. The body of the new Audi models is one of the lightest in its class due to an intelligent material mix and lightweight construction.

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| *Audi A4 2.0 TFSI quattro. Click to enlarge.* |

**Engines.** At market launch in Europe, the new Audi A4 and A4 Avant will be available with a choice of three TFSI and four TDI engines delivering maximum power of between 110 kW (150 hp) and 200 kW (272 hp). Compared with the previous model, their fuel consumption has been reduced by up to 21%, while their power output has increased by up to 25%. All engines comply with the Euro 6 emission limits, so that the TDI has been labeled a clean diesel. There is a standard 12-liter tank or an optional 24-liter tank for the required AdBlue additive.

The standard, start-stop system has also been further improved and comes with new features to reduce fuel consumption further: When the driver stops at a red light, the engine can already be deactivated below 7 kilometers an hour (4 mph); 3 km/h for the A4 3.0 TDI with tiptronic (1.9 mph).

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**New entry-level 1.4 TFSI.** The entry-level gasoline engine is the 1.4 TFSI. The compact four-cylinder with displacement of 1,395 cc has a maximum output of 110 kW (150 hp) and torque of 250 N·m (184 lb-ft) between 1,500 and 3,500 rpm. In combination with the seven-speed S tronic transmission, it accelerates the A4 Sedan from 0 to 100 km/h (62 mph) in 8.9 seconds and on to a top speed of 210 km/h (131 mph). The corresponding figures for the Avant are 8.9 seconds and 210 km/h (131 mph).

In the NEDC (New European Driving Cycle), the 1.4 TFSI with S tronic consumes 4.9 liters per 100 kilometers (48.0 US mpg) in the A4 Sedan, resulting in CO2emissions of 114 grams per kilometer (184 grams per mile). Compared with the 1.8 TFSI of the previous model, fuel consumption has been reduced by 21%.

With its aluminum crankcase, the new four-cylinder engine weighs just over 100 kilograms, despite its complex technology package. The valve-drive module in the cylinder head is designed to be light and rigid. Below it, the exhaust manifold is integrated into the cylinder head—a key element of efficient thermal management. Like the crankcase, the cylinder head has its own cooling circuit. The entire crankshaft drive has a very low mass and frictional losses.

The turbocharger and its peripherals are optimized in all details to build up boost pressure rapidly. With the mixed-flow turbine wheel, the moment of inertia is low, the electrically operated wastegate works extremely precisely and intercooler integrated into the intake manifold results in short distances for the gas mixture to travel. The common rail system develops an injection pressure of up to 200 bar; the toothed belt for valve timing and auxiliary drive is designed to last for the engine’s lifetime.

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| *Power and torque for the 2.0 TFSI. Click to enlarge.* |

**Millerized 2.0 TFSI.** The 2.0 TFSI with a displacement of 1,984 cc is available in two versions for the Audi A4 and A4 Avant. Its technical refinements are the exhaust manifold integrated into the cylinder head, the rotary-valve model for thermal management, the Audi valve-lift system (AVS) for the outlet valves, the electric wastegate of the turbocharger and the dual fuel injection. In partial load, indirect injection in the inlet manifold supplements the FSI direct injection.

In the high-end version, the 2.0 TFSI delivers 185 kW (252 hp) and torque of 370 N·m (273 lb-ft) between 1,600 and 4,500 rpm. This allows sporty driving: The new A4 Sedan with quattro drive and seven-speed S tronic sprint from 0 to 100 km/h (0 to 62 mph) in 5.8 seconds and has an electronically limited top speed of 250 km/h (155 mph). The new A4 Avant has corresponding figures of 6.0 seconds and 250 km/h. The Sedan with front-wheel drive and S tronic consumes 5.7 liters of fuel per 100 kilometers in the NEDC (41.3 US mpg) and emits 129 grams of CO2 per kilometer (208 grams per mile).

The second version of the 2.0 TFSI, the gasoline ultra model, delivers 140 kW (190 hp) and torque of 320 N·m (236 lb-ft) between 1,450 and 4,200 rpm. This also results in very agile performance: 7.3 seconds from 0 to 100 km/h (62 mph) and a top speed of 240 km/h (149.1 mph) for the Sedan; 7.5 seconds and 238 km/h (147.9 mph) for the Avant (both with S tronic).

The Sedan consumes 4.8 liters per 100 kilometers (49 US mpg) (NEDC) and the Avant 5.0 liters (47 US mpg), equivalent to 109 and 114 grams of CO2 per kilometer (175 and 184 grams per mile) respectively.

The pioneering efficiency of the 2.0 TFSI is the result of Audi’s Millerized combustion method with shorter compression and longer expansion phases as well as increased compression. The Miller cycle uses a higher expansion ratio than compression ratio (i.e., over-expansion) obtained by either early or late closing of the intake valves (EIVC and LIVC, respectively), and results in a smaller effective compression stroke; combustion and expansion proceed normally.

The Audi TFSI intake valves close much earlier than usual; in connection with increased pressure in the intake manifold, this reduces throttling losses. With the shortened compression phase, Audi engineers increased the compression ratio from 9.6:1 to 11.7:1. This means that in the compression phase, the engine only has to compress as much gas as a 1.4 TFSI. Also in the expansion phase, in which it fully utilizes its two liters of displacement, it profits from the high compression ratio; the resulting higher level of pressure during combustion further increases the engine’s efficiency.

In order for the fuel-air mixture to swirl sufficiently despite the short intake time, the combustion chambers, piston recesses, intake ducts and turbocharging of the new 2.0 TFSI are specially adapted to the new combustion method. Under higher loads, the Audi valvelift system opens the intake valves later, resulting in a higher charge, which ensures good power and torque delivery. Injection pressure has been increased to 250 bar.

**2.0 TDI.** As with the TFSI engines, Audi offers the four-cylinder TDI engines with its displacement of 1,968 cc in two power versions. The first delivers 110 kW (150 hp) and torque of 320 N·m (236 lb-ft) between 1,500 and 3,250 rpm; the second delivers 140 kW (190 hp) and torque of 400 N·m (295 lb-ft) between 1,750 and 3,000 rpm.

The 2.0 TDI clean diesel features separate cooling circuits, two balancing shafts in the crankcase, a cylinder-pressure sensor, substantially reduced inner friction and a common-rail fuel injection system with a maximum pressure of 2,000 bar. Emissions stay low due to high- and low-pressure exhaust-gas recirculation and multi-stage exhaust-gas aftertreatment including an SCR system (selective catalytic reduction).

Even the less powerful version with 110 kW ensures high performance: The A4 Sedan with seven-speed S tronic and front-wheel drive accelerates from zero to 100 km/h (62 mph) in 8.7 seconds and has a top speed of 219 km/h (136 mph); the corresponding figures for the A4 Avant are 9.0 seconds and 213 km/h (132 mph).

In combination with the manual six-speed transmission, the Sedan and the Avant have fuel consumption of just 3.8 and 4.0 liters per 100 kilometers (61.9 and 58.8 US mpg) and emissions of 99 and 104 grams of CO2 per kilometer (159and 167 grams per mile).

**2.0 TDI with 140 kW (190 hp).** In the version with 140 kW (190 hp), the 2.0 TDI clean diesel is also a highly efficient engine. With it, the new A4 Sedan with seven-speed S tronic and front-wheel drive has NEDC fuel consumption of 4.1 liters per 100 kilometers (57.4 US mpg) and CO2 emissions of 107 grams per kilometer (172 g/mi). The new A4 Avant consumes 4.2 l/100 km (56 US mpg) and emits 109 g/km of CO2 (175 g/mi).

The four-cylinder diesel engine accelerates from 0 to 100 km/h (62 mph) with front-wheel drive and S tronic in 7.7 seconds for the Sedan and 7.9 seconds for the Avant; top speeds of 237 km/h (147 mph) and 231 km/h (144 mph) respectively.

The two 2.0 TDI engines will also be available as “ultra” versions—a badge that signifies the most efficient version of each model series. Modifications to the transmission ratio, bodywork and suspension as well as the use of tires with optimized roll resistance reduce fuel consumption even further. The A4 ultra with manual transmission and 110 kW (150 hp) has NEDC fuel consumption of just 3.7 liters per 100 kilometers (63.6 US mpg) and CO2 emissions of 95 grams per kilometer (152.9 g/mi); the corresponding A4 Avant ultra consumes 3.8 l/100 km (61.9 US mpg) and emits 99 g/km CO2 (159 g/mi). No competitor in the premium segment has better figures, Audi notes.

Another 2.0 TDI engine will be added after the market launch with power output of 90 kW (122 hp).

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| *Audi A4 Avant 3.0 TDI quattro. Click to enlarge.* |

**3.0 TDI.** The two six-cylinder TDI engines in the new A4 family combine superior power with smoothness and efficiency. The 3.0 TDI clean diesel with displacement of 2,967 cc is available with power output of 160 kW (218 hp) of 200 kW (272 hp).

The three-liter diesel engine, which weighs only 190 kilograms (419 lbs), incorporates particularly complex thermal management, new cylinder heads, substantially reduced friction, a modified chain drive and an electrically adjustable turbocharger that delivers a pressure boost of up to 2.0 bar. The exhaust-gas aftertreatment system is installed directly on the rear of the engine, and its NOxtrap catalyst works in conjunction with an SCR-coated diesel-particulate filter.

In the first version, the 3.0 TDI clean diesel delivers 160 kW (218 hp). Its torque of 400 N·m (295 lb-ft) is available from 1,250 to 3,750 rpm. The A4 Sedan and Avant with front-wheel drive are projected to have NEDC fuel consumption of just 4.2 liters per 100 kilometers (56 US mpg), equivalent to CO2 emissions of 110 grams of CO2 per kilometer (177 grams per mile); these are provisional figures. This makes the TDI the world’s most efficient six-cylinder engine.

In the high-end version, the 3.0 TDI clean diesel has a maximum output of 200 kW (272 hp) and delivers 600 N·m (443 lb-ft) of torque between 1,500 and 3,000 rpm. It accelerates the A4 Sedan like a sports car—5.3 seconds from zero to 100 km/h—and easily reaches the electronically limited top speed of 250 km (155 mph). However, its NEDC fuel consumption is just 4.9 liters per 100 kilometers (48 US mpg) and it emits only 129 grams of CO2 per kilometer (208 g/mi). The figures for the A4 Avant are 5.4 seconds, 250 km/h (155.3 mph), 5.1 liters per 100 kilometers (46.1 US mpg) and 134 grams of CO2 per kilometer (216 g/mi).

**Audi A4 Avant g-tron.** The Audi A4 Avant g-tron is the second model after the A3 Sportback g-tron that customers can run on compressed natural gas (CNG) or Audi e-gas. Its 2.0 TFSI engines has an output of 125 kW (170 hp) and torque of 270 N·m (199 b-ft).

The tanks for the Avant g-tron, which will become available in late 2016, are located under the rear of the car. They can hold 19 kilograms (41.9 lbs) of gas at a pressure of 200 bar and are particularly light thanks to their novel layout. The inner layer consists of a matrix of gas-proof polyamide, while a second layer of mixed carbon-fiber-reinforced plastic (CFRP) and glass-fiber-reinforced plastic (GFRP) ensures extremely high strength. The third layer made of glass fiber helps visualize any external influences. Epoxy resin is used to bind the fiber materials.

Gas consumption of less than four kilograms per 100 kilometers (8.8 lb per 62 miles) in a normal driving cycle means extremely low fuel costs for the customer. With NEDC fuel consumption, the bivalent g-tron model drives more than 500 kilometers (311 mi) on natural gas. When the gas left in the tank is less than about 0.6 of a kilogram (1.3 lb), gas pressure falls below ten bar and the engine management automatically switches over to gasoline operation. This allows an additional range of 450 kilometers (280 mi).

The A4 Avant g-tron is particularly ecofriendly when it runs on Audi e-gas. ([Earlier post](http://www.greencarcongress.com/2012/12/egas-20121213.html).) With this synthetic methane, the company presents the first form of completely CO2-neutral long-distance mobility. Audi produces this fuel with the help of renewable energy, water and CO2 in several power-to-gas plants. The e-gas can be bought with a special filling-station card, which acts as a compensation instrument.

In parallel, Audi is continuing its research in the area of e-fuels. Together with its partners, the company has now developed a new method of producing e-gas. This secures the future supply for the rising number of g-tron models on the roads. Thanks to the new method, Audi e-gas is produced with the help of microorganisms by means of biological methanation. Compared with the previous used chemical process, the gas is produced at significantly lower ambient pressures and lower temperatures. ([Earlier post](http://www.greencarcongress.com/2015/06/20150612-audiefuels.html).)

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| *Cockpit of the Audi A4 2.0 TFSI quattro. Click to enlarge.* |

**Transmissions.** The manual transmission, which is standard equipment for all TFSI engines and for the four-cylinder TDI engine, is an all-new development. Much of its housing is made of magnesium. A spur-gear stage replaces the shaft to the front-axle differential used on the previous model, providing advantages in terms of friction and space requirements. Open gearwheels, hollow shafts and a smaller clutch reduce the transmission’s weight further with the end result that the new unit is 16 kilograms (35.3 lb) lighter than the old one.

Audi’s new seven-speed S tronic is available for all engines except the top TDI and is standard equipment for the 3.0 TDI clean diesel with 160 kW (218 hp). The dual-clutch transmission, which replaces the continuously variable multitronic transmission, features excellent efficiency. The most important improvements are a further reduction in friction, the low weight, highly efficient oil lines and a centrifugal pendulum-type absorber on the dual-mass flywheel which allows very low idling speeds.

The two compact multi-disc clutches of the new seven-speed S tronic are arranged axially behind each other instead of—as with the predecessor—radially above each other, thereby reducing drag torque. They operate two separate sub-transmissions, which are constructed like manual transmissions. They are permanently active but only one of them is connected to the engine. Gear shifts take place within a few hundredths of a second by means of clutch operations, and with virtually no interruption of traction. With the quattro transmissions, power is transmitted from the drive shaft through a spur-gear stage to the front-axle differential.

| **A4 family background** |
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| The predecessor of the A4, the Audi 80, made its debut in 1972. Four generations of the Audi 80 were produced until 1994/95, when it was succeeded by the Audi A4. |
| The five-millionth A4 rolled off the assembly line in March 2011 and another production jubilee was celebrated in the fall of the same year: the ten-millionth car in the B segment since 1972. |
| Audi has produced the A4 model family at the company’s main site in Ingolstadt since 1994 and at the plant in Neckarsulm since 2007. |
| The series has also produced rally car—the Audi Rallye quattro and the Audi Sport quattro—as well as superior track racing cars such as the Audi 90 IMSA-GTO, the A4 quattro Supertouring and the A4 DTM. |

The eight-speed tiptronic is available only with the 3.0 TDI clean diesel with 200 kW (272 hp). The smooth, rapid and spontaneously shifting torque-converter transmission is another all-new development. Its high number of gears allows the engine to be operated close to its ideal load for more of the time. A new engine-speed-adaptive vibration absorber allows the powerful V6 diesel engine to run smoothly even at just 850 rpm. The design of the gear sets and shifting elements ensures low drag torque, which results in high efficiency.

Both automatic transmissions in the new A4 series feature a wide spread of gears: Their lower gears have sporty low ratios and high ratios for the upper gears to reduce engine speed and fuel consumption. The S tronic and the tiptronic are integrated into the engine’s thermal management and designed for start-stop operation. The driver can select between modes D, S and E and can manually shift gears at any time with the selector lever or with the standard shift paddles on the steering wheel. All the driver’s inputs are transmitted to the transmission electrically (“by wire”), a quick tap on the selector lever triggers the shift command.

The new cruise control includes an efficiency function: When the driver lifts his or her foot from the accelerator pedal in mode D or E, the transmission shifts to freewheeling whenever that would result in fuel savings. This coasting mode is possible between 55 and 160 km/h (34-99 mph). The function can anticipate even more effectively when a car has the optional systems predictive efficiency assist and Stop&Go adaptive cruise control including traffic-jam assist.

Front-wheel drive is standard equipment in the new Audi A4 family. With the gasoline engines, quattro permanent all-wheel drive is available for the 2.0 TFSI with 185 kW (245 hp). For the diesel engines it is available as of the 2.0 TDI with 140 kW (190 hp) and is standard equipment for the most powerful 3.0 TDI with 200 kW (272 hp).

**Driver assistance systems and integrated safety.** All of the versions of the new models include the safety system Audi pre sense city as standard equipment. At speeds of up to 85 km/h (53 mph), the system scans the road for other vehicles and pedestrians using a windshield-mounted front camera with a range of up to 100 meters (328 ft). If there is the threat of a collision, the driver receives a series of warnings, and if necessary the car starts to apply the brakes fully. At speeds up to 40 km/h (25 ft), it can fully prevent accidents within the system limits. At higher speeds up to 85 km/h (53 mph), warnings and brake intervention can reduce the impact velocity.

The optional Audi pre sense basic works with information from a variety of different vehicle systems. Once it detects unstable driving conditions, it initiates preventive measures to protect the occupants. The front seat belts are electrically tightened, and the windows and sunroof are closed. The hazard lights are also activated.

If a collision cannot be prevented and an accident is inevitable, the multi-collision brake assist system supports the driver with controlled application of the brakes. This can help to prevent the car from skidding, which prevents further collisions.

Another standard system in the new Audi A4 and A4 Avant is attention assist, a component of the driver information system. It analyses driver behavior and issues a warning when it detects that the driver is becoming inattentive. The adjustable speed limiter, a standard feature, can be set to a particular speed ranging from 30 to 250 km/h (19 to 155 mph).

Adaptive cruise control including traffic-jam assist in the Tour assistance package Amongst the optional systems, the key feature is the adaptive cruise control (ACC) Stop&Go including traffic-jam assist. It maintains a specified distance between the new Audi A4 and A4 Avant and the car ahead; the driver can choose one of five distances and use Audi drive select to adjust the rate of acceleration and control dynamics.

The system, which relies on the signals from the two front radar sensors and the camera, interacts with the S tronic and the tiptronic to cover the full range of speeds from 0 to 250 km/h (155 mph); in manual transmissions, it starts at 30 km/h (19 mph).

The ACC’s Stop&Go function (only available with automatic transmissions) can brake the new Audi A4 to a full stop, and at the driver’s wish it can automatically resume driving again. When the system is deactivated, the distance display shows how far the car ahead is, and it warns drivers when they are tailgating. Its operating range is at speeds of 60 km/h (37 mph) and above.

Another function of the ACC, the traffic-jam assist, can take over steering at speeds of up to 65 km/h (40 mph) on well-developed roads when traffic is congested. The system uses the radar and ultrasound sensors as well as the front camera, guiding the car by gently adjusting the steering and following the traffic ahead within system limits. In doing so, the traffic-jam assist uses the lane markings and other vehicles on the road for orientation.

When the traffic-jam assist reaches its system limits—for example, when the traffic thins out or there is a sharp curve ahead—the driver has to take over again completely. The system provides warnings at different levels. As a final measure, it safely brings the A4 and A4 Avant to a full stop.

With the ACC, the Audi pre sense front safety system on board can prevent rear collisions or help minimize impact. In dangerous situations, the system gives the driver a variety of warnings to brake: visual and acoustic signals as well as a tap on the brakes. If the driver does not respond, the car first starts to brake, and simultaneously it closes the windows and the sunroof. As the only model of its class, the A4 then decelerates as much as possible if the car in front of it is still moving. The system automatically tightens the seat belts. Audi pre sense front also works when the ACC is not running.

**Predictive efficiency assistant.** Another system that is unique in its class is the predictive efficiency assistant, which is available as part of the Tour assistance package. It works in close conjunction with the adaptive cruise control, the navigation system and the camera-based recognition of traffic signs. The preselected speed adapts to the road conditions by itself, e.g. the topography of the route, speed limits and the traffic ahead.

Even when the navigation function is not on, the predictive efficiency assistant uses the data from the route to keep the driver informed about situations which call for lower speed. The system recognizes curves, roundabouts, road junctions, gradients, city limits and speed limit signs—in many cases long before the driver sees them. A corresponding warning appears in the combination instrument and/or the Audi virtual cockpit and head-up display. If the assistant screen is active, detailed graphics can be seen.

If the driver wishes, the system can take over the freewheeling of the automatic transmission itself under certain conditions. This form of “coasting” is only activated if it can last for at least five seconds. When it ends, the car automatically accelerates to the speed the driver has selected if the ACC is activated. The predictive efficiency assistant can reduce fuel consumption on country roads by up to 10%.

**Other systems.** The Audi active lane assist is available separately or as part of the Tour assistance system. At speeds of 65 km/h (40 mph) and above, it helps drivers stay in their lanes. It receives its signals primarily from the front camera, which detects lane markings.

If the new Audi A4 and A4 Avant approach a marking when the driver has not switched on a turn signal, the system makes a gentle adjustment to the electromechanical power steering to bring the car back into its lane.

Using the MMI system, drivers can decide whether this support should be activated at all times or only take place before the lane marking is crossed. If they choose the early-correction mode, the system will guide the car back into the middle of the lane. There is also the optional setting of making the steering wheel vibrate as a signal.

The avoidance assist is yet another high-end feature in the Tour assistance system. It activates when the new Audi mid-sized models have to avoid an obstacle so as to prevent an accident. Within fractions of a second, it uses data transferred from the front camera, the ACC and radar sensors to calculate the distance of the car ahead as well as its width and degree of offset. Its first warning is a tap on the brakes to alert drivers to the potential danger. As soon as the driver starts steering, the system offers support with the necessary lane changes with controlled interventions to the power steering.

The turning assist monitors oncoming traffic during left turns (on cars with left-hand drive). It has an operating range between 2 and 10 km/h (1.2 and 6.2 mph). In dangerous situations, it brings the car to a complete stop. The system becomes active in the background as soon as the driver turns on the left turn signal.

The camera-based traffic-sign recognition assist (also available separately) rounds out the Tour assistance system. It identifies many traffic signs, including digital displays, and shows them to the driver as graphics in the head-up display and instrument cluster. The driver can also opt for visual warnings when he or she exceeds the speed limit indicated on traffic signs.

**City assistance system.** The options in the City assistance system include the lane-changing feature Audi side assist (also available separately). From speeds of 15 km/h (9.3 mph) and above, it supports drivers in changing lanes, using the two rear radar sensors which measure across a range some 70 meters (230 ft)

If another vehicle approaches quickly or is in the blind spot, a warning LED in the housing of the appropriate side mirror lights up. If the driver turns on the turn signal anyway, the LED blinks brightly many times in succession.

Upon request, the Audi side assist can be complemented by integrating the Audi pre sense rear system. It warns about potential collisions from behind and takes preventive measures such as activating Audi pre sense basic. Furthermore, it makes the hazard lights blink rapidly as a way of warning traffic behind the car. It remains active in the background at every speed even if the Audi side assist is turned off (unless a trailer is in use).

The rear cross-traffic assist is activated when the parking assist is turned on. When this occurs, drivers who are slowly driving backwards (for example, while leaving a parking spot at right angles to the road) are warned about approaching vehicles in critical range. There are different levels of warnings: visual, acoustic and a short jolt of the brakes. The back radar sensors provide the necessary data.

The exit warning is activated when the new Audi A4 and Avant stop moving. If other vehicles are approaching from behind, it warns occupants as they open the doors. The system warns drivers by means of LED fiber optics in the inside door-opening mechanism (contour lighting). In situations that are assessed as dangerous, special high-performance red LEDs blink and light up. The exit warning stays on for approximately three minutes after the ignition is turned off.

Other systems complete the City assistance package: the acoustic and visual park system plus, which automatically activates when it detects an obstacle, and the reversing camera. Both systems are also available separately.

**Parking assistance system.** The Parking assistance system features the park assist (also available separately). With the help of twelve radar sensors, it helps maneuver the car into parking spaces that are parallel or at right angles to the road, which it identifies independently when driving at a moderate speed. Furthermore, it can make its own way out of parking spaces parallel to the road. All the driver has to do is accelerate, shift gears and brake.

The 360-degree cameras are the second component of the package. The MMI monitor displays different perspectives from the car’s immediate surroundings, including a virtual view and 180 degree images from the front and rear. Guidelines make it easier to maneuver in reverse gear. The 360-degree cameras are especially helpful in dealing with parking spaces or driveways where visibility is poor, and the cameras are also useful together with the rear cross-traffic assist in the rear.

**Internal connectivity.** A fully equipped new Audi A4 or A4 Avant has some 90 control units on board, many of which exchange data with each other. This kind of tight-knit interaction, especially among the driver assistance systems, would not be possible without a new approach to the car’s electronic architecture.

The new FlexRay bus system connects several control units with each other and guarantees extremely rapid and secure data transfer. The most important components are the engine, the automatic transmission, the central chassis control unit, electronic stabilization control (ESC), the power steering control unit, the adaptive cruise control Stop&Go including traffic-jam assist, the video camera and the safety computer which steers the safety systems.

There are other data networks in addition to the FlexRay bus. CAN (controller area network) buses connect some of the assistance systems such as the Audi side assist, 360 degree cameras and the air-conditioning system. Furthermore, they are part of the communication between the convenience functions, the infotainment components and the central display and control components, such as the MMI and Audi virtual cockpit.

LIN (local interconnect network) buses complement the CAN buses by operating less complex integrated systems such as interior lighting. The Bang & Olufsen sound system with 3D acoustics uses a MOST (media oriented systems transport) bus. In these new Audi mid-sized models, the electric systems also contribute to the light vehicle weight: enhanced topology, new aluminum cables and an AGM battery lower the weight by six kilograms (13 lb) in comparison with the earlier model.

**Stuttgart/Germany, September 2009—MAHLE is using a compact, highly turbocharged three-cylinder gasoline engine to demonstrate the potential that lies in its technologies. Tests on the 1.2-l engine are proving that downsizing rates of up to 50 percent are possible.**

The gasoline engine, in particular, benefits from downsizing because smaller engines often operate at higher load ranges—where combustion is more efficient in gasoline engines than at lower loads. To demonstrate the potential benefit of downsizing in the short term and evaluate individual modifications in a complete system, MAHLE has developed a 1.2-l gasoline engine prototype. With a power output of up to 144 kW and a torque rating of 287 Nm, this engine has what it takes to replace an engine with twice its displacement. Yet the MAHLE engine is extremely fuel-efficient: Based on fuel consumption data, a simulation of the New European Driving Cycle (NEDC) in a vehicle weighing 1.6 metric tons indicated a potential improvement in fuel efficiency of greater than 30 percent compared to the 2.4-l reference engine.

For the development and production of the demonstrator engine, MAHLE drew upon the combined expertise of the entire Group. For example, the weight-optimized, intricate structures of the cylinder head, engine block, and oil pump were made to the required quality standards using the MAHLE COSCAST® aluminum casting method.

To mitigate the high thermal load brought about by exhaust gas turbocharging, a particularly efficient cooling concept involving crossflow cooling at the cylinder head was developed, and high-performance coatings and materials are used for a large number of components. The cooling system uses a thermal management system tailored to the specific needs of the application to optimize the overall efficiency of the engine.

Two key MAHLE technologies, in particular, make the engine powerful, clean, and fuel-efficient:

**Variable valve train**
The demonstrator engine design uses four-valve technology with two overhead camshafts. Phasers at the intake side and exhaust side allow independent adjustment of the valve timing. Low-friction roller-type cam followers increase the efficiency of the valve train, as do the low weight, small moving masses, and low wear of MAHLE lightweight valves cooled with a sodium filler.

**Exhaust gas recirculation**
The demonstrator engine is outfitted with a cooled exhaust gas recirculation system for EGR rates of up to 15 percent. This lowers the peak combustion temperature so the engine emits fewer nitrogen oides. Fuel consumption is reduced by eliminating full-load enrichment and dethrottling in the partial load. The engine is designed for compliance with EURO 5 emissions standards.

**Exhaust gas turbocharging (EGT)**
Today, the demonstrator engine is available in two versions: For the 100-kW-to-120-kW performance class, the design utilizes single-stage exhaust gas turbocharging. It is with the two-stage turbocharger design that the demonstrator engine achieves its peak performance. In this design, two exhaust gas turbochargers are configured sequentially.

The turbine housing of the high-pressure-stage EGT is integrated in the manifold. Here as well, exhaust gas is drawn into the turbine directly from an exhaust port. The high-pressure stage is activated at low rpms and continues to compress the exhaust gases up to an engine speed of 2,500 rpm. Once this limit has been reached, all of the exhaust flow is redirected to the low-pressure EGT by means of a bypass valve located between the exhaust manifold and the low-pressure EGT. At this point, the second turbocharger takes over the turbocharging function for the entire remaining rpm range up to a maximum engine speed of 7,000 rpm. The compressor casing of the high-pressure EGT (on the air side) features a pressure regulating valve.

**Fast electrical wastegate actuator ready for serial production**An electrical wastegate actuator recently introduced by MAHLE—for the first time in a series production application—makes it possible to implement a fast control strategy for the turbocharger. This does away with "turbo lag," therefore resulting in enhanced responsiveness. Moreover, because the exhaust gas back pressure can always be kept to a minimum, fuel consumption is lowered.

With the pneumatic actuators used previously, the control speed was too slow for this, and the wastegate could only be controlled when sufficient charge air pressure was available. The new actuator passes through the entire range of adjustment in just 80 milliseconds.

For the first time, the MAHLE electrical wastegate actuator makes available a cost-effective, fast, and precise actuating mechanism that is capable of controlling the wastegate irrespective of the pressures occurring in the system. In addition, the actuator enables a reduction in the charge exchange work taking place, resulting in achievable fuel savings of up to four percent.

The MAHLE Group is one the top 30 automotive suppliers and the globally leading manufacturer of components and systems for the internal combustion engine and its peripherals. Around 45,000 employees work at over 100 production plants and eight research and development centers. In 2008, MAHLE generated sales in excess of EUR 5 billion (USD 7.3 billion).