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Valeo is an independent and international Group fully focused on the design, production and sale of components, systems and modules for cars and trucks, both on the original equipment market and the aftermarket. Valeo ranks among the world's top automotive suppliers.

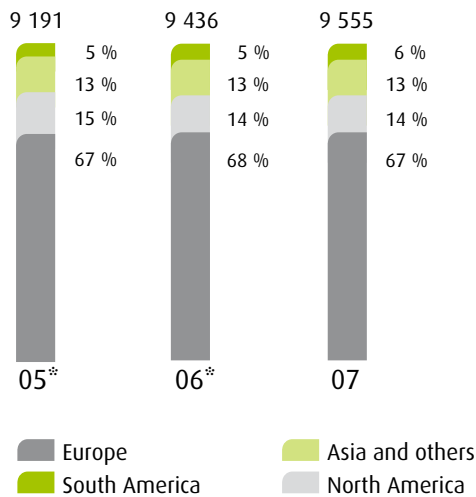
## Key figures 2007

# 9,7 billion euros

sales in 2007

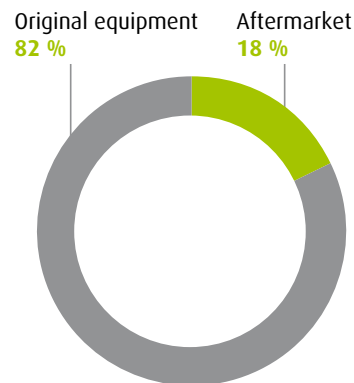
### Sales by region

in million euros, and in % of sales



### Sales by market

in % of sales



\* Data restated to take account of the disposal of the wiring harness business in 2007.

## Global presence

Valeo works with automakers in all countries where they wish to operate.

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**61 200**

people

**93** nationalities,

125 production plants,  
62 R&D centers,  
9 distribution centers

in **28** countries.

Global solutions for local  
production.

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### Western Europe

- > 55 production sites
- > 36 R&D centers
- > 6 distribution centers
- > 29 420 employees  
(Belgium/Netherlands, Germany, France,  
Ireland, Italy, UK, Spain, Sweden)

### Eastern Europe

- > 13 production sites
- > 1 R&D center
- > 2 distribution centers
- > 10 480 employees  
(Czech Republic, Hungary, Poland Romania,  
Slovakia, Turkey)

### North America

- > 14 production sites
- > 12 R&D centers
- > 6 830 employees  
(Mexico, USA)

### South America

- > 10 production sites
- > 1 distribution center
- > 4 200 employees  
(Argentina, Brazil)

### Asia

- > 30 production sites
- > 12 R&D centers
- > 8 770 employees  
(China, India, Iran, Japan, South Korea,  
Thailand)

### Africa

- > 3 production sites
- > 1 R&D center
- > 1 500 employees  
(Egypt, South Africa, Tunisia)

## Innovation, the cornerstone of Valeo's strategy

Designing the automobile of tomorrow, creating technologies and products in line with the market demand, while anticipating its expectations: these are the fundamental principles of Valeo's Research & Development strategy. In 2007, R&D spending represented 5.5% of sales, and 545 new patents were filed.

Innovation is the core of the Group's development strategy, and is based on three Domains: Driving Assistance, Powertrain Efficiency and Comfort Enhancement. The Domains develop responses to market demands, offering innovative solutions to the automotive industry that reconcile environmental protection, safety and driving pleasure.

To provide the best response to motorists' expectations, a thorough understanding of the market and consumer perceptions are vital to Valeo's R&D process. The opinion of users provides essential input for the design and development of new products, and Valeo regularly organizes focus groups with consumers. They provide an opportunity for the public to test new or future automotive products. This process helps Valeo choose which systems to develop.

**Powertrain Efficiency** is the Domain which reconciles the automobile and the environment by contributing to the creation of cleaner, more fuel-efficient vehicles. Valeo is a leader in this field, boasting a large number of commercially available solutions which include engine and thermal management, exhaust gas recirculation, transmissions and a micro-hybrid starter-alternator. When combined, these solutions can lead to savings in fuel consumption of up to 40%.

**Comfort Enhancement** is the Domain dedicated to optimizing the health and well-being of drivers and passengers, thus reconciling the automobile and comfort. This Domain has generated many applications, including systems for filtering and purifying the air in the cabin, vehicle access, ergonomics and the Human Machine Interface (HMI).

**Driving Assistance** is the Domain which reconciles the automobile and safety, offering systems that monitor the driver's immediate environment, alert them to the presence of hazards and, when combined with other onboard systems, can transmit the information required for an instant reaction. Valeo has developed a full range of radar, ultrasonic and camera-based systems which provide drivers and vehicle systems with 360° vision by day or night.

# StARS starter alternator

Valeo's StARS starter alternator is a major innovation for the global automotive industry, as it takes up the challenge of reducing vehicles' fuel consumption and CO<sub>2</sub> emissions

## Energy and environmental issues

The automotive industry is faced with a number of global issues: the need to reduce greenhouse gases, especially CO<sub>2</sub> emissions, the gradual depletion of easily reachable oil reserves, and the severe economic pressure exerted by skyrocketing oil prices. The sector will therefore have to invest heavily in effective and economically viable fuel-saving technologies.

## Perfect battery temperature regulation

In urban areas, cars are at a standstill for almost 35% of the time, with the engine idling needlessly. Valeo has developed a particularly effective solution to this problem: StARS (Starter Alternator Reversible System), which shuts the engine off when the vehicle stops, at a traffic light, for example, and starts it up again as soon as the driver asks for power. This Stop-Start function is fully automatic and can achieve fuel savings of up to 25% in congested city driving. Not many innovations can claim that!

The StARS solution combines the alternator and starter functions. As a starter, it starts up the engine instantly and silently using the alternator belt. StARS uses a new technology that enhances its electrical efficiency and generates additional fuel savings. With these two major benefits, this starter-alternator is an ideal product offering genuine fuel savings, and improved comfort, with the elimination of vibrations and noise from the idling engine when the car is stationary.

Thanks to its advanced design, the StARS starter alternator can be adapted to any Stop-Start strategy required by the car-maker. The system can also take into account a multitude of parameters related to the engine, clutch, gearbox, brakes or other comfort and safety equipment. It also allows the engine to be restarted when the vehicle is driving slowly and is in the process of stopping, if, for example, the driver unexpectedly changes their mind. Conventional starters do not offer this function. StARS can be used with all types of transmission and all types of engines: Diesel, gasoline or other fuels.

In 2004, Valeo became the first automotive supplier to market a starter-alternator. StARS was launched on the Citroën C3 1.4l 16V, and then on the Citroën C2. Today's Smart Fortwo mhd (micro hybrid drive) also offers the benefits of the StARS starter-alternator, which generates fuel savings of 19% in heavy urban traffic. In standard cycle, consumption is reduced from 4.9 l/100 km to 4.3 l/100 km and CO<sub>2</sub> emissions are cut to 103g/km. StARS also equips on the Mercedes A and B Classes' 1.5l and 1.7l «Blue Efficiency» gasoline models. Valeo has signed a contract with PSA Peugeot Citroën to supply Stop-Start technology for over a million vehicles by 2011.

Valeo's StARS starter alternator won the 2006 PACE Award and the Grand Prix of the EPCOS/SIA Jury, distinctions that underscore the interest shown by the automotive industry in this solution.



## Operating principle

The StARS starter alternator is a synchronous machine with a claw rotor and air cooling. It uses three-phase current and MOSFET field-effect transistors instead of diodes for its direct current rectification. This gives excellent efficiency, at 75% (VDA measurement), or 10 points higher than a traditional alternator. StARS provides current up to 180 Amperes. As a starter, StARS requires current of 600 Amperes, generating considerable power for the immediate start-up of the engine. This allows the machine to start the engine in less than 0.4 seconds, before immediately switching to alternator mode.

The starter-alternator is driven by the front-end belt. A reversible tensioner allows power to be transmitted in both directions, depending on whether the StARS starter-alternator is working as a starter or an alternator. The AGM battery uses a special technology that tolerates a greater number of discharge-recharge cycles and is fitted with a sensor that enables the system to inhibit the Stop-Start function if the charge level is too low or to restart the engine if the charge level drops below a critical threshold.

## StARS starter alternator benefits

### Benefits for the carmaker

- The StARS starter alternator offers significantly reduced fuel consumption and CO<sub>2</sub> emissions for a very reasonable cost.
- At 2.5 kW at 14 V, the starter power is high.
- Electrical efficiency, at 75% (VDA measurement) is ten points higher than that of a conventional alternator.
- The engine can be restarted when in the process of stopping, if, for example, the driver unexpectedly changes their mind.
- With the integrated electronics allowing it to be simply installed on the engine, the system is installed just like a normal alternator.
- The length of the powertrain is not increased, as it is when starter-alternators are incorporated in the shaft line.

### Advantages for the user

- Fuel consumption is reduced by up to 25% in dense urban traffic.
- CO<sub>2</sub> emissions are reduced by up to 25% in dense urban traffic.
- The engine cuts out and restarts automatically.
- The engine restarts in less than 350 milliseconds.
- The engine restarts noiselessly.
- Engine noise and vibrations are eliminated when the vehicle is at a temporary standstill, which represents 35% of urban driving time.



# Dual dry clutch

Automatic transmission with the dual dry clutch has proved to be the most effective and best suited to the needs of the European market

## An automatic gearbox that delivers

European motorists are finally turning to automatic transmission, which simplifies driving by carrying out gear changes itself. This makes hill starts and parking maneuvers more comfortable, and driving in built-up areas and heavy traffic more relaxing. Users do not want to see higher fuel bills, however, and would like automatic transmission to be more affordable.

## The dual dry clutch: a perfect solution

The dual-clutch transmission concept is a response to end-users' demands for both increased driving comfort and fuel savings, unlike traditional automatic transmission which increases fuel consumption. Valeo offers a dual dry clutch developed using its manual gearbox experience. The controlled sliding of the two clutches is designed to offer maximum comfort when shifting gears. Valeo's offer includes the clutches and actuators. This solution couples technologies already tried and tested in series production, such as bonded rather than riveted linings, and others, such as travel adjustment integrated within the actuators, specially developed to ensure dual-clutch strength and reliability.

When combined with electro-mechanic actuator technology, dual dry clutches offer significantly higher performance than that of the hydraulically actuated double wet clutch systems. The solution therefore offers fuel savings and CO<sub>2</sub> emissions reductions of around 4% and at least 6% compared to an automatic gearbox.

## Operating principle

The dual dry clutch offered by Valeo contains three pressure plates. The central pressure plate is fixed axially and linked to the engine's flywheel. A clutch disk is pressed by a moving pressure plate on each side of the central plate. The clutch on the plate's motor side engages both when starting and when shifting to odd gears. The clutch on the gearbox side engages when shifting to even gears and reverse. Each of the two parts of the dual clutch module alternately transmits torque to one of the two coaxial input shafts of the transmissions: one is hollow and is used for even gears, and the other is solid and used for odd gears. The pressure plates are engaged by an electromechanical actuator applying a force, via a release fork, to a diaphragm spring that presses onto the corresponding moving pressure plate. When stationary, the two clutches are disengaged because, unlike manual gearboxes, they are actively closed for safety reasons.

To obtain maximum comfort during gearshifts, the opening of the first clutch must be perfectly synchronized with the closing of the second. Careful choices of masses and materials ensure that the dual clutch module has sufficient thermal capacity to absorb the energy released during the synchronization phase. Valeo therefore utilizes its Freepod® facings with bonded linings offering a longer clutch plate life. This exclusive patented technology allows the total thickness of both facings to be reduced and this is used to optimize the thermal mass, which is key in efficient dual dry clutch operation.



The clutch actuator requires the balancing of the forces applied by the clutch diaphragm and those by the actuator. In order to reduce the energy needed to power the electric motor, the actuator includes an assisting spring, which uses a cam to exert a force close to that of the diaphragm. The electric motor then provides the additional force required to control the clutch engaging and disengaging actions, thereby consuming less energy. 15 Amperes electric current are required during gearshifts, but only 1 Ampere is required between gearshifts to keep the clutches closed. This contributes to the exceptional efficiency of Valeo's dual dry clutch. The actuators lastly include a bidirectional travel adjustment mechanism that adjusts for facing wear and also adjusts automatically for production tolerances. This last point simplifies the vehicle assembly process.

The dual dry clutch can be fitted in conjunction with a dual mass flywheel if required for particular diesel or gasoline engines. Current developments can cover torque up to 350 Nm depending on the space available, the vehicle weight and the first gear ratio of the transmission.

## Dual dry clutch benefits

### Benefits for the carmaker

Valeo offers a highly efficient dual clutch system, providing exceptional performance:

- Dual dry clutches are more efficient than dual wet clutches, because:
  - the clutch plates are dry instead of being immersed in an oil bath, requiring a hydraulic pump;
  - they use electromechanical rather than hydraulic actuators.
- The system results in a reduction of more than 6% in CO<sub>2</sub> emissions compared to a conventional automatic gearbox and a reduction of about 4% compared to a wet friction dual clutch gearbox.
- Reliability is ensured by the careful choice of technologies that minimize the number of dual clutch components, the use of clutch facings with bonded linings and the wear adjustment mechanism integrated in each actuator.
- The dual dry clutch can be easily adapted to a large number of gearboxes.

### Benefits for the user

The customer enjoys better performance, greater fuel economy and improved comfort and driving pleasure:

- The Valeo dual dry clutch provides the driving comfort of automatic drive transmission coupled with lower fuel consumption than that offered by a manual gearbox.
- The sporty nature of the transmission adds real driving pleasure to this design.





# Direct battery cooling

Valeo offers an efficient battery cooling system for hybrid and electric vehicles

## The challenge of producing efficient batteries

In the medium term, hybrid and electric vehicles will answer a very strong market demand. They will provide solutions to meet both the decline in oil reserves and the necessity to reduce CO<sub>2</sub> and pollutant gas emissions. Battery performance is one of the key conditions for successful mass marketing of this type of vehicle.

## Perfect control of battery temperature

Valeo has developed a system to control the temperature of lithium-ion batteries. The unique feature of this system is direct cooling, which keeps the battery at its ideal working temperature. The system comprises an evaporator that is built into the battery module and is connected to the vehicle's conventional air conditioning circuit. This evaporator, which is inserted between the cells, releases cold to enable heat exchange.

This is a direct cooling system, which means that it is totally integrated into the air conditioning circuit. There is no second water or air circuit to recover the cold and convey it to the battery.

The cooling system is powerful enough to ensure that the lithium-ion battery functions optimally. In this way, the battery can more efficiently recover kinetic energy during braking, which is then used to accelerate. Furthermore, keeping the temperature below 40°C helps to lengthen the battery's lifetime, which is estimated to be 10 years.

## Operating principle

R134a fluid air conditioning circuits divide their energy between two parallel-mounted evaporators: the first one, for the cabin, positioned in the HVAC (Heating, Ventilation and Air Conditioning) unit and the second one, which is built into the battery module. Evaporators are usually made up of a multitude of tubes that form a radiator. In order to integrate the evaporator into the battery, these aluminum tubes are coiled in the space available between each cell. Aluminum fins, secured by a plastic frame, are used for an ideal heat exchange between the cells and the coils. Each cell is in contact with two coils – one in the outward circuit and the other in the return circuit – in order to make sure that the temperature of the cells is even. Finally, the system is sound-proofed in a steel casing.

The battery is cooled by a direct loop in the air conditioning system. A second water/glycol type loop or an air exchanger circuit is not necessary. This direct cold circuit is very efficient, which helps to cut the vehicle's overall consumption. It also offers an excellent cost/performance ratio by using the existing compressor and eliminating the need for an additional pump. It is also compact, reduces the volume of piping and does not require the installation of air hoses or a distribution unit.

The direct battery cooling system is compatible with three different battery configurations: 4 rows of 9 cells, 3x12 and 2x6. Valeo has succeeded in producing a system that is light, especially in view of its high performance. By way of example, the system for a 42 cell module weighs just 2.2kg.

## The benefits of direct battery cooling

### Benefits for the carmaker

- The temperature of the lithium-ion cells remains even.
- Direct loop cooling is highly efficient.
- Excellent cost/performance ratio.
- Soundproofed by the steel casing.
- Available for three different battery layouts.

### Benefits for the user

- This efficient cooling system enables the lithium-ion battery to function optimally, especially during the energy recovery and delivery cycles.
- Keeping the temperature below 40°C helps to lengthen the battery's lifetime, which is estimated to be 10 years.

# CNG sequential injection

Fuelling vehicles with compressed natural gas (CNG) is one of the most realistic short-term solutions for reducing CO<sub>2</sub> and motoring costs

## Facing current challenges

The automotive industry is currently facing particularly difficult environmental challenges, and is following several leads in order to reduce pollutant emissions, greenhouse gases and fuel consumption. For economic and technical reasons, however, not all solutions can reach the market quickly.

## CNG in original equipment

CNG is a realistic solution to this problem, reducing carbon dioxide emissions by 20% compared to gasoline. With its relatively low cost, it is the most affordable automotive fuel, at an estimated €0.05 per kilometer, followed by LPG (€0.059 per kilometer), diesel (€0.063 per kilometer) and gasoline (€0.091 per kilometer)<sup>(1)</sup>.

The biggest markets today are Iran, India, Pakistan, Argentina, Brazil and Italy. Most European countries offer CNG as original equipment on one or more models for the public and professional markets, including the Citroën C3, Renault Kangoo, Peugeot Partner and Citroën Berlingo and several models by Mercedes, Opel, Volvo and Fiat. Gas reserves are estimated to be twice as extensive as those of oil.

Valeo has developed ways to adapt gasoline engines to CNG. From the design of the components to their development, integration and manufacture, Valeo has applied the same high standards it applies to gasoline vehicles. With considerable experience in bi-fuel engine management and electronic modules, Valeo can offer carmakers a range of parts that can be integrated into existing engines, including ECUs, injectors and sensors. Injection and ignition have a specific cartography in CNG engines in order to ensure minimal loss of power, reduced consumption, complete reliability and greater driving comfort than gasoline engines. The software includes a full diagnostics system to help with after-sales service, and the carmaker offers the user a complete guarantee.

CNG is largely composed of methane (CH<sub>4</sub>), whereas LPG is a mixture of propane and butane. Unlike LPG, CNG also has the advantage of being lighter than air, and is therefore safer in the event of a leak, because the product does not remain on the ground. CNG engines can start in temperatures as low as -10°C. Below this level, the car must be started with gasoline. Vehicles can be mono-fuel or bi-fuel, using both gasoline and CNG.

## Operating principle

CNG is stored at 200 bars in one or more tanks, and is taken to the engine compartment in a stainless steel flow line. A release valve then reduces pressure in the collector to 2 bars, and a ramp takes the gas to the injectors. Valeo chose to design specific CNG injectors instead of adapting gasoline injectors which were designed for lower volumes, which would require a gas supply at between 7 and 9 bars. Supplying gas at under 2 bars uses the gas in the tank more efficiently, increasing the vehicle's autonomy by 5%. The injectors are opened by electromagnets and closed by a membrane under the pressure of the gas.

The injectors are controlled either by a second electronic module connected, in master-slave mode using a CAN protocol, to the ECU managing gasoline operation, or to a bi-fuel ECU. In both cases, the cartography for the sequential injection and ignition is specific to gas, and automatically adapts to the composition of the gas. CNG programming manages the four injectors, pressure and temperature sensors and solenoid control valves for the tank and the pressure release. The software also communicates constantly with the gasoline software, to collect information from a probe, for example,



or the canister solenoid valve or sensors (knock, speed, or collision detection inertia). Software controlling the switch between the two modes ensures that the transition is completed smoothly. The system has a specific catalytic converter, which takes into account the gases' different chemical composition. The system is compliant with Euro 4 or 5 standards.

CNG mode requires specific tuning, both in terms of the duration of injection and the ignition point. If these settings were based on the gasoline system, the loss of power would reach 20% or 30%. Despite the long development period, therefore, Valeo has opted to add a specific cartography which cuts power loss down to just 7%. This residual figure is due partly to the compression rate that is set for gasoline, and therefore too low for CNG, which does not generate much knocking, and partly to the gaseous state of the fuel, which takes up a lot of room in the cylinders, restricting the amount of air that can be taken in. Turbocharging would more than offset this loss and offer 15% more power than in gasoline mode.

All EOBD surveillance and diagnostic operations are managed by the electronic module, whether CNG or bi-fuel, because they are included in the electronic programming as soon as they are developed.

## Valeo CNG benefits

### Benefits for the carmaker

- Guaranteed reliability and durability.
- Power loss limited to 7% by specific cartography.
- Diagnostic capacity identical to gasoline operation.
- Bi-fuel ECU that is easy to integrate, more economical and more compact than a second electronic module.
- Depollution level of Euro 4 or 5 standard.
- Low pressure injection increases the proportion of usable gas from the tank.
- Guaranteed safety of the CNG adaptation.
- Gaseous fuel does not wet the walls of the intake ducts and cylinders in cold starts, reducing both consumption and pollution.
- No calamine is formed and there is no risk of diluting the oil.

### Benefits for the user

- Cost of around €0.05 per kilometer, 15% less than gasoline, 21% less than diesel and 45% less than LPG1.
- Guaranteed reliability because bi-fuelling is researched in partnership with the carmaker.
- Power loss limited to 7%, less than an aftermarket system.
- 20% cut in CO<sub>2</sub> emissions.
- Carmaker guarantee.
- Preservation of ease of use and driving comfort.
- Governmental assistance: cost of fuel and, in France, the government's "green bonus".
- CNG + gasoline bi-fuelling offers significant autonomy.
- Users with a gas connection can install a compression and filling system at home.

<sup>(1)</sup> According to average fuel prices recorded in France in the first half of 2008 and average fuel requirements for each kind of engine.



# e-Valve: the electromagnetic valve control system

Valeo is the world's first automotive supplier to demonstrate the robustness of electromagnetic valve control systems. In addition to cutting fuel consumption and CO<sub>2</sub> emissions by as much as 20%, the system can also be perfectly integrated with electric hybrid engines.

## The need for a new technology

Rising fuel prices and the pressing need to cut CO<sub>2</sub> emissions are two issues that the automotive industry must address and solve quickly. While new drive concepts are being developed, they will not be available on a mass scale in the near future. Therefore, it is essential to improve the overall efficiency of the internal combustion engine, not by making minor tweaks here and there, but by proposing quantum steps forward in terms of technology.

## A tried and tested technology

For many years now, Valeo has been working on electromagnetic valve control systems, which represent a fundamental improvement to the internal combustion engine. Valeo's e-Valve technology allows automakers to reduce vehicle emissions and consumption by 15% to 20% in the EEC mixed driving cycle. This significant gain is all the more advantageous because it only requires a few components of the powertrain to be changed. In combination with the StARS+X hybrid system, fuel consumption can be reduced by as much as 30%.

The e-Valve system replaces the traditional mechanically driven camshaft with an electromagnetic control system that actuates each valve individually and independently of the position of the crankshaft. In addition to the almost unlimited scope for timing settings and variations in the opening times, e-Valve also enables each valve to operate independently, which means that a given number of cylinders can be deactivated. This feature drastically improves the ecological performance of the internal combustion engine. By way of example, it is now possible to optimize engine performance with respect to the instantaneous power requirements of the driver, applying different engine strategies such as cylinder deactivation or the Atkinson-Miller cycle. This flexibility in engine valve control also significantly increases low-end torque, enhancing driving comfort. Finally, the e-Valve system is part of the trend towards the electrification of vehicle components, and in particular electric hybrid engines.

Valeo is the first automotive supplier in the world to demonstrate the robustness of its electromagnetic valve control system. The e-Valve has progressed well beyond the conceptual design stage and demonstrations on prototype vehicles, to a point where it can be mass produced.

## Operating principle

The fundamentally specific feature of e-Valve is that valve control is totally independent of the position of the crankshaft. Each valve is actuated by two electromagnets that are specifically dedicated to opening and closing the valves. The two opposing springs alternately provide the force required to open and close the valves. The whole unit is controlled by an electronic management system (the Valve Control Unit) with an integrated 14/42 Volt converter and cooling system.

By replacing the inlet butterfly valve, the e-Valve system also does away with pumping losses that are due to the partial closure of this valve (high negative pressure during inlet travel when the demand for pressure is low) and are detrimental to fuel consumption. As a result, idle speed can also be lowered. Engine manufacturers also have a broad choice of settings, which are no longer fixed but are infinitely and continuously variable. This development helps to reconcile parameters that were previously antagonistic, such as torque at low rpm, power at high rpm and the reduction



of fuel consumption and emissions. Deactivating certain cylinders by temporarily closing their valves enables the active cylinders to work in a more efficient load bracket. The combination of all these new options reduces fuel consumption and CO<sub>2</sub> emissions by 15 to 20%.

In addition, more and more on-board systems are switching to by-wire controls. Electromagnetic valve control systems are just one example. This development is perfectly in line with another underlying trend towards electric hybrid road vehicles, which recover the kinetic energy generated by braking, which would otherwise be wasted. In this case, driving the valves with the e-Valve system requires no additional energy. Another point of compatibility between these two advanced technologies is that the e-Valve system allows the engine to start when the valves are open. This feature facilitates synchronization between starting the engine and the Stop-Start function, which will soon be installed in a greater numbers of cars.

### The e-Valve system in detail

The e-Valve system has two actuators, one for each pair of valves. Valve movement is controlled by two magnets that harness the energy released by two opposing springs. At the start of the valve opening operation, the valve is released by the upper magnet. The upper spring releases, driving the valve's descent. The lower magnet catches the armature plate, fully compressing the lower spring and keeping the valve open for the required time. Valve closure follows the identical procedure in reverse. The valve is kept closed by a locking strategy, reducing the energy being consumed by the magnets. The valves also remain closed while the engine is not running. Noise due to the opening and closing of the valves is managed by controlling the speed of the valve as it reaches the upper and lower limits of travel.

The Valve Control Unit (VCU), which is cooled by the engine cooling system, operates on a standard 12-Volt vehicle architecture. It is equipped with a voltage converter to locally power the actuators with 42 Volts.

The flexible e-Valve system allows infinitely variable valve timing and valve opening duration, along with the possibility to deactivate some cylinders. In addition, by opening and shutting valves faster than a cam system at low engine speeds, pumping-related losses are reduced and almost eliminated. As well as improved thermodynamic performance and torque, it is also possible to use several strategies, such as switching momentarily to a Miller cycle, or accelerating gas intake speed and turbulence by opening one valve, thus reducing the creation of pollutant gases. The system also facilitates the introduction of new combustion processes, such as HCCI or multi-stroke, including two-stroke. Current tests on prototype vehicles are focusing largely on half-camless systems, which control inlet valves only and offer most of the benefits and an excellent cost-benefit ratio.

The e-Valve system also benefited from a new development process designed to achieve greater robustness. The use of robust 6-Sigma engineering methods and digital simulation enabled a broad range of configurations to be precisely validated without making any physical parts, since the model had already been validated. Only the final configuration was produced at the end of the new development cycle, an approach that saved a lot of time and offered a remarkable level of quality of the final product. The tests matched the simulations perfectly and demonstrated the robustness of the e-Valve system under real working conditions: temperature variations, vibrations, severe conditions, etc. The system is now ready for industrial production, because the constraints relating to manufacturing dispersions have been solved. The product is now completely «repeatable», which means that all functions are available under all circumstances and over time. The development process went through a number of evolutions, including the addition of a hydraulic stop to compensate for the mechanical play in the system and the use of a highly precise and durable valve position sensor.



## E-Valve system benefits

### Benefits for the carmaker

- Valeo is the first automotive supplier in the world to demonstrate the robustness of its product.
- The e-Valve system is ready for industrial production.
- Pumping losses are reduced to virtually zero, which improves performance and lowers the idling speed.
- Engine manufacturers benefit from almost infinitely variable valve opening settings, with a positive effect on torque, especially at low rpm, NO<sub>x</sub> and HC emissions and the recycling of exhaust gases.
- The system is highly adaptable in terms of cylinder capacity, types of injection, types of admission, and for engines that are already in production with conventional distribution by camshafts.
- The introduction of new operating strategies is simplified: disconnection of cylinders, HCCI combustion, multi-stroke, including two-stroke, etc.
- Starting the engine is made easier when using the Stop-Start function.
- While the electromagnetic system controls both the inlet and exhaust, the mechanical part is simplified as the valve actuation belt or chain, and camshaft, are no longer required.

### Benefits for the user

- Consumption is reduced by 15-20%.
- CO<sub>2</sub> emissions are reduced by 15-20%.
- Low-end torque is increased by 15-20%.
- Greater ease of use when restarting with the Stop-Start function.
- In combination with the StARS+X hybrid system, fuel consumption and CO<sub>2</sub> emissions can be reduced by as much as 30%.



# Exhaust Gas Recirculation (EGR)

Valeo, European leader in Exhaust Gas Recirculation systems, offers new solutions in emissions reduction

## Emissions reductions are necessary

Diesel engines offer lower fuel consumption and CO<sub>2</sub> emissions than gasoline engines. The rejected pollutant gases - carbon oxide (CO) and unburnt gas (HC) - are reduced by optimal combustion and post-treatment in a catalytic converter and self-regenerating particle filter. This leaves the nitrogen oxides (NO<sub>x</sub>) emitted by diesel engines, and most countries are lowering the maximum legal level of these emissions.

## A tried and tested solution

Valeo's Exhaust Gas Recirculation (EGR) is an efficient, cost-effective system for reducing NO<sub>x</sub>. The high-pressure EGR loop takes part of the exhaust gases at the cylinder head outlet and re-injects them into the air intake. The main benefit is that NO<sub>x</sub> is reduced at the source by limiting the quantities formed in the combustion process, rather than by post-treating the gases. The result is a cleaner combustion process.

Diesel gases are only recirculated under specific conditions, when the engine is idling or only lightly loaded. The system uses an electric valve, which fully or partially opens the recirculating circuit, depending on the operating phase of the engine. The valve is driven by a powerful electric motor that guarantees reliable operation, even under the severe constraints imposed by temperature and a highly corrosive environment. The maximum throughput is high and the control of the valve position allows the recirculation rate to be precisely adjusted. The system works in association with an electric throttle valve on the intake side that reduces the quantity of intake air. It is completed by a heat exchanger between the recycled gases and the engine's cooling circuit, which lowers the temperature, thereby increasing the reduction of NO<sub>x</sub>. The quantity of cooled gas is controlled by a bypass choke included in the system between the EGR valve and the exchanger.

Valeo's experts at its Engine Cooling Branch are also developing other advanced concepts, such as a high-pressure EGR loop combined with post-treatment system that paves the way for the adoption of the future Euro VI standard. The idea is to recover the gases before the exhaust turbine, treat them with a catalyst and re-inject them into the intake after the charge air compressor. Another of Valeo's advanced projects is a low-pressure EGR loop which increases the volume of recycled gases and dispenses with post-treatment. Unlike high-pressure architectures, in which the gases are recovered before the turbo turbine, where pressure is high, the low-pressure loop takes gases after the turbine, where the pressure is lower. Valeo has designed and developed a three-way valve on the intake side, enabling this kind of architectural innovation.

It is also developing an innovative application for supercharged gasoline engines. The use of this kind of system will be decisive in the future of this kind of engine: EGR will reduce fuel consumption and carbon dioxide emissions by around 7-8%. These reductions are provided by lower combustion temperatures, which increase the engine compression rate - and efficiency - and also save fuel and cool combustion under heavy loads.

As a leader in this field, Valeo has a complete range of competitive solutions based on high- and low-pressure architectures for gasoline and diesel engines. With the expert knowledge of the Engine Management Systems and Engine Cooling branches, the Group has the skills required for research and development of the exhaust gas recycling function. Its solutions meet the most challenging of automakers' demands in terms of cost, quality and reliability.





## Operating principle

The new electric EGR valve is made up of an electric motor, gearing, a cam system, a valve and a position sensor. With a high-power DC motor, the valve can be fully opened or closed in just 100 and 75 milliseconds respectively. One of the system's most distinctive features is the progressive cam-driven control device that converts the rotary movement of the engine into controlled downward travel of the valve. The cams can be used to apply several priorities according to valve travel. The valve's opening mechanism must be very reliable: in a highly corrosive environment, there is a danger of the valve being jammed by soot deposits or oil combustion residues. The rotation/travel ratio of the cam increases the thrust force by significantly gearing down the movement. Once the valve is open, the second priority is the speed of travel of the valve. The gradient of the cam is then gradually increased. The cam also ensures that the valve can be closed tightly and quickly. The cams are linked to the valve by two bearings that eliminate friction and risk of seizure.

Valeo has opted for an outward-opening valve for greater dependability, since the high exhaust gas pressure generated by a turbocharger applies a force that tends to close the valve. Pressure loss in the gas recycling circuit is low thanks to the clearance area, the aerodynamics of the valve head and the small diameter of the shaft. This property is especially important when idling and with very low loads. A Hall-effect sensor precisely measures the position of the valve. This is an important point, since a precise recirculation rate reduces the flow tolerances and, importantly, enables the engine to meet the Euro V standard which comes into force in 2009.

The capacity to cool the exhaust gases is another major factor contributing to the reduction of  $\text{NO}_x$ , and Valeo has succeeded in improving the heat exchange capacity with the engine coolant. The round corrugated tubes developed for Euro IV have been replaced by flat corrugated tubes to meet Euro V emission standards. This increases the heat exchange surface, resulting in thermal efficiency of 85%, and a reduced exhaust gas pressure drop. The U-shaped heat exchange circuit reduces the dimensions of the part. The gases can bypass the cooler via a pneumatically controlled flap. This function is essential for Euro V-compliance and is useful after engine cold start, when the temperature in the combustion chamber must increase quickly in order to minimize toxic emissions.

## $\text{NO}_x$ reduction in detail

High quantities of nitrogen oxides are produced in combustion at high temperatures with excess air. Consequently, both of these parameters must be reduced. By recycling part of the exhaust gases into the intake, the mass of intake air is reduced, as are the quantities of oxygen and nitrogen available for combustion. This can be achieved with the partial closing of the throttle valve. Lower quantities of oxygen also help to lower the combustion temperature. The heat exchanger, which is cooled by the engine's coolant, lowers the temperature of the recycled exhaust gases, which in turn reduces the combustion temperature. The temperature can be further reduced by incorporating the UltimateCooling™ concept, which is capable of further lowering the temperature of the coolant whenever necessary.

Exhaust gases are only recycled under certain conditions, when the engine is idling or only partly loaded, because in these circumstances, combustion occurs with a significant excess of air.



## EGR Valve Advantages

### Benefits for the carmaker

- The EGR system avoids the need for NO<sub>x</sub> post-treatment devices.
- The power of the cam-controlled electric motor offers dependability and enables the valve to be opened and closed quickly.
- The valve remains closed in the event of a malfunction.
- The U-shaped circuit reduces the dimensions of the exchanger.
- The exchanger and bypass valve are protected against high temperatures and exhaust gas surges when the EGR valve is closed (when the valve is on the exhaust side).
- The thermal efficiency of the heat exchanger is 90% with minimal exhaust gas back-pressure.
- Valeo is the only supplier of full EGR systems that include the valve and heat exchanger.
- Valeo already offers innovative solutions for increasing the rate of gas recycling in diesel engines, and cutting CO<sub>2</sub> emissions from gasoline engines by 7-8%.

### Benefits for the user

- EGR allows vehicles to meet the requirements of the Euro IV and upcoming Euro V standards without impacting the price, unlike post-treatment solutions.
- A forthcoming solution for supercharged gasoline engines will reduce fuel consumption and CO<sub>2</sub> emissions by around 7 to 8%.



# THEMIS™ electronic valve

Smart cooling enhances engine efficiency

## Improving engine cooling management

The central concerns of motorists continue to focus on reducing emissions and saving fuel, and increasing the efficiency and user comfort of the internal combustion engine. One key way to achieve these goals is the smart regulation of temperature and coolant flows.

## Intelligent management of temperature

Valeo has a solution that replaces the traditional thermostat. THEMIS™ (THErmal Management Intelligent System) is an electronic valve (with associated control strategies) that constantly optimizes, under all conditions, the flow and temperature of the engine coolant.

Located at the outlet of the engine's cooling circuit, it consists of a four-way rotary slide valve that progressively opens the engine cooling radiator, bypass and cabin heating circuits, with the position of the slide valve controlled by an electric motor and measured by a sensor.

Predictive controller software allows precision control of the flows, which provides optimal functioning of the engine, especially during transition phases. THEMIS™ also enables faster heating of the cabin, and maintains cabin thermal comfort even after the engine has been switched off. The system provides optimized thermal distribution where and when it is needed.

## Operating principle

Variations in heat dissipation can be anticipated by using a rapid-response valve controlled by intelligent control-unit algorithms. A conventional wax thermostat's operation is controlled by the temperature of the coolant flowing through it and does not react to the powertrain's immediate needs, sometimes resulting in an operating lag. With THEMIS™, however, the opening and closing of each circuit is managed by predictive controller software developed by Valeo, which integrates the current temperature, engine data and driving style parameters. The system readjusts the flows before each measurement and incorporates a closed loop to handle minor fluctuations.

The valve's electronic control ensures that the coolant maintains its optimum temperature - 110°C when lightly loaded, for example - while limiting deviations to  $\pm 2^\circ\text{C}$  (compared with  $\pm 7^\circ\text{C}$  for a conventional thermostat). The valve opens in less than 1 second, instead of 20 seconds with a standard thermostat, improving engine performance. When heavily loaded, bringing the temperature down to 90°C can restrict knocking, improve combustion and reduce temperature stress. The oil temperature and viscosity can also be controlled more accurately, resulting in lower friction-related energy losses. The result: improved fuel consumption, CO<sub>2</sub> emissions, pollutant gas emissions and performance.

Other engine functions are also improved. "Zero flow" mode is provided when the THEMIS™ valve completely closes all of the circuits. This mode is used on a cold start, enabling the temperature of the combustion chamber walls to rise rapidly and improving heat transfer to the engine oil. Test results on a gasoline engine have shown a 30°C rise in temperature of the cylinder head metal in the first few seconds after the engine is first started. Unburned hydrocarbon and carbon monoxide emissions, along with engine oil dilution with fuel resulting in a shorter engine life, are therefore reduced.



The THEMIS™ valve also considerably improves cabin comfort. Hot coolant normally passes continuously through the heater core in the air conditioning system, and parasitic thermal waste reduces the air conditioning's performance in summer. In this case, the THEMIS™ valve closes the hot coolant circuit to the heater entirely. A reduction of up to 5°C in the vent discharge air temperature has been measured, improving passenger comfort, reducing the effort demanded of the air conditioning compressor and consequently generating fuel savings.

The THEMIS™ valve used in conjunction with a low-powered auxiliary water pump in the cabin comfort circuit can assist in maintaining a comfortable temperature during temporary stops and avoids problems linked to engine overheating if it is shut off after some time at full load, in which case the engine will continue to be cooled by water that also runs through the radiator.

## THEMIS™ Valve benefits

### Benefits for the carmaker

- Engine efficiency is improved by maintaining the water temperature at 110°C when the engine is running slowly. A related 3% reduction in fuel consumption has been measured in testing.
- The water temperature is adjusted according to the engine's load, and is 90°C when heavily loaded.
- "Zero flow" mode accelerates the engine's temperature rise when cold, reducing the production of pollutants. Hydrocarbon emission reductions of 10% and carbon monoxide emission reductions of 20% have been measured under mixed cycle conditions (MVEG).
- The THEMIS™ valve improves engine and cooling system reliability:
  - The engine does not overheat if switched off after a long period at full load, at the top of a hill, for example
  - The risk of spark knock is reduced due to the speed of the THEMIS™ valve's action
  - Engine thermal shocks are eliminated
  - Radiator thermal shocks are eliminated
  - A safety device opens the circuits in the unlikely event of an electrical failure.
- By closing the cabin heating circuit, the air conditioning compressor's and water pump's workload is reduced. The air conditioning compressor and the water pump can both be downsized.
- The THEMIS™ valve facilitates effective heating in hybrid vehicles and Stop-Start vehicles.
- The THEMIS™ valve is easy to install in the engine's water outlet unit.

### Benefits for the user

- Fuel consumption is reduced due to improved engine temperature management.
- CO<sub>2</sub> emissions are reduced as a result.
- Engine and radiator reliability is improved.
- The cabin is heated more rapidly after the engine is started up in winter during urban driving conditions.
- Air conditioning is more efficient.



# UltimateCooling™ System

UltimateCooling™ reinvents the vehicle's thermal architecture

## Cumbersome cooling systems

The cooling needs of comfort functions, engine efficiency and reliability, and the transmission of considerable power require an increasingly complex and bulky architecture. The cooling module located in the front end can therefore include up to four exchangers: oil and water radiators, charge air cooler and air conditioning condenser.

This adds considerable weight and takes up a lot of space, while cooling is poorly optimized, undermining vehicle efficiency and cabin comfort.

## Reinventing cooling architecture

Valeo's new UltimateCooling™ concept utilizes a single coolant fluid for all heat exchangers, limiting the number of front-end exchangers and improving thermal flows. The idea is to cool all the exchangers - either with the normal hot loop, or with an additional cold loop - and to locate them as close as possible to the part that needs cooling.

An electric water pump, coupled with a valve (if required), provides the coolant flow according to the required uses and priorities. The cold loop feeds the charge air cooler located at the cylinder head intake, the fuel cooler and the air conditioning condenser. The hot loop is responsible for cooling the liquid circulating in the cylinder block and the cylinder head, and the engine or transmission oil, and heating the cabin. The exhaust gas recirculation (EGR) system cooler and other additional systems may be connected to one or the other of the loops, according to the specifications of the carmaker.

The hot and cold loops are cooled either by a single dual-circuit radiator or by two separate radiators. Making the circuits both more efficient and more compact. The circuits are therefore more efficient and less bulky, requiring less space in the vehicle's front-end. This will help meet future pedestrian impact standards, and reduce the number of refrigerant gas leaks and repair costs in the event of front-end impacts.

## Operating principle

The sizing of conventional cooling circuits is based on extreme use scenarios. The air conditioning system's condenser is sized for operation when idling and/or at low speeds, whereas the engine's radiator and the charge air cooler are sized for driving at maximum speed or towing a trailer in mountainous conditions. A single coolant is used to 'share' the capacities of all front-end heat exchangers, and thereby improve their efficiency. UltimateCooling™ reduces the volume of the thermal management system while providing equal performance, or increased performance for equal volume.

UltimateCooling™ will give priority to cooling the air conditioning system's condenser during startup conditions, or the engine in hot weather (to cool down the vehicle) and as such will exploit the heat exchanging capacity of both radiators. Similarly, when considerable torque is required, the charge air cooler will utilize the heat exchanging capacity of both radiators.

The cold loop's architecture within the vehicle allows optimal positioning and simplified arrangement of the various exchangers, and reduces the volume of the hoses transferring liquids from the engine to the chassis.

The cold loop can also provide efficient cooling for the electronics and motor-generators of hybrid and fuel cell vehicles.



It is also possible to adjust the UltimateCooling™ system's efficiency by means of a control valve between the hot and cold loops. In certain cases, only part of the high-temperature radiator will be required to cool the engine (during urban and highway driving or when ambient temperature is below 35°C, conditions frequently experienced when driving a vehicle), leaving the rest of the radiator's potential to cool other functions.

Lastly, a reduction in the number of heat exchangers in the front-end of the vehicle reduces the depth and height of the module, facilitating compliance with «pedestrian impact» standards. In a middle-range prototype produced by Valeo, the maximum depth is reduced from 118mm to merely 50mm with a multi-temperature radiator or 60 mm with two radiators, and the total volume of the cooling systems is reduced by 22%.

## UltimateCooling™ benefits

### Benefits for the carmaker

- The intake air cooling system is more efficient. Its circuit is shorter, reducing the transitory response lag under acceleration, and the pressure loss between the charge air compressor and the intake manifold is also reduced.
- Engine performance is increased and pollutant emissions are reduced.
- The improved efficiency of the charge air cooler and the air conditioning condenser increases the vehicle's overall energy efficiency. Fuel consumption can be reduced by up to 6% in a MVEG mixed cycle with the air conditioning operating.
- The multi-temperature radiator reduces the front-end module's dimensional requirements by 40% and maximum depth requirements by approximately 50%.
- The possibility of relocating the condenser reduces the risk of coolant leaks in the event of front-end impacts, representing a potential volume of 750g of R134a liquid corresponding to approximately 1 tonne of CO<sub>2</sub> in terms of greenhouse effect.
- The EGR and fuel circuits can be cooled by the cold loop.
- The cold loop can also provide efficient cooling for the power electronics and electric motors of hybrid and fuel cell vehicles.

### Benefits for the user

- The UltimateCooling™ system reduces fuel consumption by up to 6% when the air conditioning is operating.
- The engine produces more power.
- In the event of a front-end impact:
  - Repair costs are reduced,
  - The risk of leaks is minimized.



# Water-cooled charge air cooler

The water-cooled charge air cooler improves acceleration and reduces consumption by up to 2% compared to a conventional air-air cooler

## Improved turbocharging

Most diesels, and an increasing number of gasoline engines, are turbocharged. Turbocharging increases power for the same cubic displacement, or produces the same level of power with reduced fuel consumption and pollutant emissions. The performance of the turbocharger is improved by cooling the compressed air, which automatically improves specific power and lessens pollution.

## The trend towards air-water coolers

The intake air entering gasoline or diesel turbocharged engines is traditionally cooled by an air-air heat exchanger located at the front of the vehicle. Valeo has developed a different concept for improved air cooling: an air-to-water heat exchanger in which the air leaving the compressor is cooled by a cold water flow. The main benefit is more efficient cooling, thanks to the heat capacity of water, which is four times greater than that of air. Furthermore, the intake air circuit is shorter, which reduces the engine's lag time when accelerating sharply.

The Valeo water-cooled charge air cooler's first mass-production application was introduced in the Volkswagen Golf TSI engine exhibited at the 2007 IAA Frankfurt Motor Show. The unit represents the first step towards Valeo's new global cooling concept, UltimateCooling™.

## Operating principle

The water-cooled charge air cooler is made of brazed aluminum and provides considerably reduced pressure losses. It is located in the engine's intake manifold, eliminating the need for hoses between the engine and the front end of the vehicle. The reduced volume between the compressor outlet and the intake valves reduces response time when accelerating. The time taken to reach maximum turbocharging pressure at the engine intake is cut by about 250 milliseconds at 1,500rpm, or 14%.

The charge air cooler's coolant circuit is totally independent of the engine's cooling circuit. Since its temperature is no more than 15°C to 20°C higher than the ambient temperature, this circuit is known as the «cold loop». The intake air temperature rises by less than 5°C under acceleration at full load, compared with 20-30°C for an air-to-air system, owing to its greater efficiency and thermal inertia. The coolant is then cooled by a small radiator, which is located at the front or on the side of the vehicle and fed by small-diameter (approximately 20mm) coolant hoses. The coolant is pumped by a small electric pump.



## Water-cooled charge air cooler benefits

### Benefits for the carmaker

The Valeo air-to-water heat exchanger offers many advantages over a conventional air-to-air cooler:

- More efficient cooling and low internal pressure losses.
- The efficiency of the engine is improved, because the intake air is cooler, and therefore denser, for an equivalent power consumption of the turbocharger compressor. Alternatively, the power absorbed by the compressor is reduced for the same mass of intake air.
- Pressure losses between the compressor and the cylinder block inlet are reduced. This cuts consumption, because the compressor does less work for the same mass of intake air. Here again, one alternative is to improve the engine's performance for the same quantity of work done by the compressor, thanks to increased air density.
- For the same power output, the thermal loads applied to the engine's structure are reduced, because all the temperatures in the cycle are lower. Alternatively, the power of the engine can be increased for the same thermal loads.
- The engine's lag time when accelerating is reduced as a result of the shorter distance covered by the air between the compressor and the inlet valves.
- It is easier to control the combustion parameters, because the intake temperature is almost constant.
- The unit is more compact: the cooling module in the front end of the vehicle is up to 20% smaller, and the long charge air ducts leading to a heat exchanger at the front of the vehicle have been eliminated. Installation of a turbo- or supercharged engine in the engine compartment is simplified.
- This concept simplifies implementation of the phase 2 pedestrian impact standard 2003/102/EC.
- Repairs resulting from a front impact are reduced.
- The water-cooled charge air cooler enables the introduction of future low-pressure EGR systems that can handle nitrogen oxide production more efficiently in diesel engines and the use of full-load EGR systems in gasoline engines.

### Advantages for the user

- An improved engine response time when starting to accelerate.
- When coupled with the longer gear ratios accepted by turbocharged engines, the intake air cooler's improved efficiency reduces fuel consumption by up to 2%.





# High-performance air conditioning

Valeo's high-performance air conditioning cuts overall vehicle consumption by 3%.

## Air conditioning consumption

The need to reduce consumption and CO<sub>2</sub> emissions does not only concern the powertrain. Every item of equipment in the vehicle can make a contribution. Depending on the model, an air conditioning system that is used intensively can consume between 5 and 12% of the engine's power. A more efficient system, generating the same amount of cold while consuming less, would be especially beneficial.

## A 30% drop in absorbed energy

As a worldwide specialist in automotive air conditioning systems, Valeo can enable automakers to cut power absorption by 30% in comparison with existing systems. As a result, fuel consumption and CO<sub>2</sub> emissions can be reduced by 3%.

This performance is achieved by using new components that are managed by innovative control algorithms. The air conditioning system features a number of advanced components, including the adaptive regulator, a high-performance evaporator and a self-contained internal exchanger. A variable-displacement cylinder with improved yield is also used.

## Operating principle

The control algorithms in a dedicated controller guarantee optimal operation under all circumstances: quick cooling of a very hot cabin, maintaining a comfortable temperature, demisting, etc. This smart control system relies on new servo-control mechanisms. For example, the smart management of the electric fan limits power consumption to the strict minimum. The system is also equipped with a temperature sensor at the compressor outlet, which can be used to apply optimization algorithms to a new system.

Valeo has also improved the performance of its compressor with seven axial pistons. The cubic displacement can be varied from 0 to 170 cm<sup>3</sup> and the external control of the inlet pressure delivers just the right flow for a given situation. This solution avoids the unnecessary generation of cold. Efficiency has also been boosted by a design that includes an oil separator and improved discharge valves.

The cold circuit is fitted with an internal exchanger for a back-flow thermal exchange in the coolant between the high- and low-pressure outlets of the condenser and the evaporator. This internal exchanger increases the cooling power and improves overall energy efficiency. Lastly, the HVAC unit is fitted with a high-performance evaporator made up of die cut alloy plates that form two layers of back-flow micro-channels (dual unit) and square-based spacers.



## High-performance air conditioning benefits

### Benefits for the carmaker

- A 30% drop in absorbed energy:
  - Reduced consumption and CO<sub>2</sub> emissions, less weight and more compact thanks to the reduced dimensions of the compressor and the drive mechanisms,
  - Or enhanced comfort thanks to the improved performance of the air conditioning system.
- Improved efficiency for R134a technology or any alternative synthetic fluids.

### Benefits for the user

- 3% reduction in vehicle consumption.
- 3% reduction in CO<sub>2</sub> emissions.
- Improved comfort.



# Control panels

Valeo is meeting automotive manufacturers' needs for change in the control panel area through new concepts that offer greater design freedom, harmonized interiors, and easy, intuitive operation

## Current Human Machine Interfaces must change

Today's cars offer sophisticated HVAC and multimedia systems. While this makes travelling comfortable and pleasant for the car's occupants, the center stack area tends to be overloaded with a complex array of different controls. What is more, drivers want to be able to use their personal devices while driving in a safe way. Automakers are therefore facing a dilemma: how to offer an increased number of functions while keeping the same ease of use, perfect ergonomics and making driving safe?

## A wide range of new control solutions and concepts

Valeo is responding to the need for new kinds of controls in the center stack area with several interface technologies that can simultaneously manage air-conditioning and all multimedia applications - radio, CD, MP3, and GPS - without compromising their content. This HMI (Human-Machine Interface), known as the faceplate, is available independently of applications such as HVAC or radio.

The increase in the number of functions is driving the introduction of multifunctional displays which are useful in the management of varied and sometimes complex applications.

Valeo already offers a solution: the Multi Control Interface located between the seats. When combined with a screen, it makes application management even easier. The controls are based on a joystick or/ and combined with touch screen. The latter integrates character recognition so it is easy to write text messages or enter a destination in the navigation system.

Valeo is also working on a new multifunctional solution, a faceplate combined with a touch screen. The driver can browse through different applications thanks to the easily reachable color touch screen. Direct commands for frequently used functions, such as cabin temperature control, radio volume or e-call, are directly accessible on the faceplate control panel.

There is special focus on the ease of use and on the ergonomics of these new solutions together with the finish, harmonized styling so as to fully satisfy automakers' expectations.

Technologies developed by Valeo, such as the "black mask", contextual back-lighting, magnetic notching, proximity sensing (capacitive or resistive) combined or not with tactile or sound programmable feed-back are appreciated by automakers looking to customize fit and finish. In this way they can enhance brand image with smooth, innovative designs.

The entire range of these products can be adapted to various styling requirements in line with automaker needs and can be produced with shiny, metallic, chrome or brushed aluminium finishes.

Valeo, an HMI specialist, with over twenty years of experience in this field, has anticipated change by offering control systems that cater for an increasing number of functions in the cabin while meeting new styling requirements.

Valeo is working together with automakers on research into new HMI concepts, which it tests on users in static or dynamic conditions for its various markets, and integrates technical and economic specifications for mass production.



## Benefits of Valeo control panels

### Benefits for automakers

- Control panels customized to specific brand identity.
- Harmonized design of different control systems.
- Increased styling possibilities.
- Differentiation capacity through wide selection of technologies that meet marketing, technical and economic needs.
- Innovative systems such as touch sensitive surfaces with vibration feedback.
- Controls for the complete car interior controls range.
- From dedicated HMI to multi-functional HMI.
- Controls that can manage a wide range of systems.
- Space-saving via the integration of controls into a single product.
- Increased possibilities for managing a large number of functions without compromising the content.
- Modular HMI solution able to follow function deployment depending on trim-level and cross-platform.

### Benefits for users

- Intuitive controls.
- User-friendly with a pleasant feel.
- A range of functions in a small, accessible space.
- Pleasant and harmonized interior design.
- Safe interface solution for external user devices.



# E-Media™ controls

The E-media™ control console helps motorists control even the most sophisticated on-board comfort and communications devices quickly and in complete safety

## Making the most of control capacity

Many drivers find electronic control consoles far too complex, with lots of menu levels that demand close attention and prevent users from making the most of all the functions offered by the vehicle's equipment.

## Simple, intuitive controls

Valeo has developed an easy-to-use control console that can be used intuitively to adapt and control the vehicle's equipment, without limiting the range of possibilities offered by electronic technology.

The E-Media™ control console has three separate joysticks, each fitted with a contact sensor that can be used to display a menu by simply touching the joystick. Each function menu has no more than two levels. Valeo's ergonomics and design specialists paid close attention to the graphical user interface that perfectly illustrates the structure of the system. The vehicle's central screen schematically displays the position and use of each control. Bars and arrows are used to represent rotations or lateral and longitudinal sideways movements. Some functions are controlled by rotating the joystick, while others use buttons in order to make the use of the system more natural.

## Operating principle

Each joystick can be moved in three ways: rotation to the left and right, linear movements in all four directions and pushing downwards.

Between 8 and 32 angular positions can be selected by rotating the joystick, which has a magnetic indexing system for more comfortable movements and reduced wear. The menu of the controlled function can be displayed on the screen by simply touching the joystick, a solution that does away with one level of menus. The system uses capacitive sensors that measure the change in electrical resistance between the vehicle and the user's body.

The logic of the controls is the result of an in-depth ergonomic analysis. By way of example, the air conditioning menu appears in the bottom right-hand corner of the screen, while the joystick used to control the air conditioning is on the right at the rear of the console. The control movements are clearly shown using circles, bars and arrows. The most frequently used or basic functions (audio volume, temperature, telephone directory) are controlled by rotating the joysticks, while safety devices and occasional functions, such as the demister or picking up the telephone, are directly accessed using buttons.

Another unique feature of the E-Media™ control console is the possibility of communicating with all the vehicle's systems using the CAN, MOST or other protocols.



## E-Media™ control benefits

### Benefits for the carmaker

- The E-Media™ system reduces the number of buttons, without limiting the number of functions.
- It can control a multitude of functions using the CAN, MOST or other protocols.
- The finish can be easily customized (illuminated central symbol) and additional functions can be included (touch detection, magnetic indexing).

### Benefits for the user

- The E-Media™ system controls numerous functions and offers a broad range of possible settings.
- The graphical representation on the screen shows the position of the control and the movements used to adjust the function. The driver's eyes remain on the screen rather than on the joystick for safer use.
- The system is simple and intuitive to use. The user's attention remains focused on driving the vehicle.



# Senseative® seat controls

Senseative® offers new touch-sensitive, easy-to-use controls.

## Easier to use

Electric seats are increasingly common in vehicles. They are usually controlled using a 3D model representing the back and cushion of the seat. Moving either one of these parts horizontally or vertically causes the corresponding part of the seat to move. But users often have difficulty finding and using these controls.

## A new technology

The Senseative® touch-sensitive seat control represents a significant step forward in terms of ease of use. The 3D model makes way for four segments corresponding to the possible movements of the seat and the electric buttons are replaced by a touch-sensitive system with four resistive sensors. The different parts of the seat can be moved by simply sliding a finger on the corresponding segment, then pressing the button.

## Operating principle

Each segment has a resistive sensor, measuring about 250 microns in thickness. The resistance of this electronic component varies in accordance to the pressure that is applied to it. By pressing the sensor, a proportional signal is sent to the electronics, when the resistance drops directly below a preset value. At the same time, resistors embedded in the sensor detect precisely where the sensor is being pressed. The control can also be used with gloves. To actuate the system, it is necessary to first slide the finger on the selected segment, and then press until the required position is reached. In this way, accidental movements are avoided.

This type of flat control device offers numerous possibilities for different finishes and customization. It can be covered with plastic, silicon or metal. It can be illuminated by LEDs or display characters or pictograms using an electroluminescent foil. Finally, tactile data can be transmitted by the built-in actuators.

Senseative® technology is not restricted to electric seat controls. It can also be used to improve the ergonomics of a number of functions: interior lighting, sun roofs, telephone keypads or entering addresses by recognizing handwriting.

## Senseative® control benefits

### Benefits for the carmaker

- Great design freedom thanks to flat controls that can be easily integrated into the surfaces of the vehicle and possible application of different high-quality coatings (metal in particular).
- Compact technology that can be used to increase the number of functions, even in places that are not visible.
- Controls can provide visual or tactile feedback.
- Flat controls reduce the risk of accidental damage.
- Reduced number of parts (tools, process, etc.).
- Watertight integration that meets IP54 standard.

### Benefits for the user

- A new generation of more intuitive and effortless controls.
- Can even be used with gloves.
- Operating principle that eliminates the risk of accidental movement.
- Modern design.



# Air quality in the cabin

Valeo offers solutions that increase in-vehicle comfort by purifying and improving the quality of air in the cabin

## Air pollution

Motorists are becoming increasingly demanding when it comes to the quality of air in the cabin. Many of them spend a lot of time in their vehicle, where the air quality is often deteriorated by pollutants from different sources. The air can contain unpleasant smells, allergens, pollutant gases and particles from different combustions.

Surveys have shown that the quality of air inside a vehicle can be from two to five times worse than that of the air outside.

## Multiple responses from Valeo

Valeo proposes several filtration technologies that keep the air in the cabin healthy and pleasant. By filtering out different types of pollutants, our solutions protect the occupants and improve their well-being through the addition of innovative functions.

The first level of air purification proposed by Valeo is a filter protecting the occupants against particles measuring between 0.1 and 10 microns that are present in the air in urban areas. The second level involves a combined filter that filters particles and provides protection against pollutant gases and odors, thanks to a layer of active carbon. These two filters can also perform an anti-allergen function by applying a natural surface treatment that deactivates the allergens that are present in the air during periods of pollination.

An air purifier is also available. This self-contained module filters out particles, gases and odors. It includes a positive and negative ion generator that makes the air healthier by reducing the number of bacteria in the cabin. This ion generator can be integrated in the air conditioning system or used alone.

In addition to these air purification systems, Valeo also offers a fragrance dispenser to further improve the comfort of the occupants. This new system, which is separate from the air conditioning, includes two perfumes and an intensity control.

Another innovative high added value product available from Valeo is the vitamin C filter. As well as filtering particles, this system permanently dispenses a precursor of vitamin C, which prevents dry skin through improved hydration.

## The benefits of Valeo's cabin air quality products

### Benefits for the carmaker

- A broad range of specific filters: particles, pollutant gases and allergens.
- Innovative, high added value products:
  - vitamin C filter that prevents dry skin in the cabin;
  - fragrance dispenser that creates an unique olfactory atmosphere in the cabin.
- An air purification module that improves the quality of air in the cabin by reducing concentrations of particles, gases and bacteria.

### Benefits for the user

- A complete range of filters for the different pollutants present inside vehicles.
- A fragrance dispenser that further improves on-board comfort.
- The innovative vitamin C filter that improves the hydration of the skin.





# Thermeo: the additional air conditioning module

The electric Thermeo module improves your air conditioning system by sending warm or cool air to the rear seats

## Immediate and even climate control

Users are always looking for increased cabin comfort with temperature evenly distributed between the front and rear seats and a vehicle that warms up before the engine reaches its working temperature.

Because air conditioning vents are located at the front of the cabin, very little cool air reaches the rear passengers. Current solutions consist in installing a second air conditioning system, but this is costly and takes up cabin space, which is why this option is reserved for top-range models only.

## An additional and independent air conditioning system

Valeo now offers a real alternative with its electric Thermeo air conditioning solution. There is no more need for high-pressure pipes, evaporator fluid and distribution lines. All the lightweight and compact Thermeo system needs to produce and dispense cool air is a 12 V power supply. Thermeo can offer different temperatures on the left and right and can provide warm air even before the engine has reached its normal operating temperature. The system also comes with a remote control.

Already available for carmakers, Thermeo will later be offered as an accessory that can be connected to a power outlet inside the vehicle.

## Operating principle

Thermeo is an electric module that uses the Peltier effect. As a direct electric current passes between two plates containing a bismuth telluride-based semiconductor, a heat transfer occurs. One of the plates heats up, while the other one cools down. The Thermeo module is equipped with a quiet fan that blows air across the cold plate and then towards the occupants. The hot plate is cooled by a second air flow that is expelled to the exterior.

The system is powered directly by a 12 V supply. Electricity consumption is very low: 100 W to reduce the temperature by 5°C, and 250 W to increase the temperature by 25°C.



## Thermeo module benefits

### Benefits for the carmaker

- Thermeo can produce hot or cold air immediately.
- It provides passengers in two rows of back seats with warm or cool air, without having to install a large and costly additional air conditioning system.
- There is no need to install air ducts for the rear of the vehicle. Thermeo includes its own dispensers and can be attached to the ceiling.
- With a single electrical connection, Thermeo can be quickly and easily installed by dealers, while its low power consumption means no changes to the vehicle are required.
- Thermeo can be used with a standard HVAC (heating, ventilation and air conditioning) unit on a platform used with different body shells.

### Benefits for the user

- Increased comfort for passengers in the two back rows, without having to install a large and costly second air conditioning system.
- In the winter, warm air is produced immediately, without having to wait for the engine to reach its normal working temperature.
- Two-zone controls.



# Smart car key

The Valeo smart key communicates with vehicle over long distances and controls new functions

## Long-distance connection

The possibility of communicating with a vehicle over long distances can be very helpful. Users can make sure that their vehicle is locked and that the doors and trunk are closed and check the current condition of the car, without having to use the on-board computer. They can also be informed of possible problems, pre-program vehicle functions and even transfer data from a computer.

## Extended functionality

The prototype smart key developed by Valeo is an extension of the existing hands-free system. It can be used to control new functions, including the pre-ventilation of the cabin, and works over longer distances. Feedback from the vehicle is indicated by a light or a buzzer.

If a command cannot be executed, warning messages are sent and the user is guided through the steps to understand and solve the problem. The current state of the vehicle is displayed on a mini-screen: door locks, alarm, temperature in the passenger compartment, fuel level and tire pressure. The smart key can also be used to transfer data that has been downloaded from a computer, such as navigation addresses, to the vehicle's on-board system.

## Operating principle of the smart key

The main innovation is a long-distance communication system between the key and the vehicle. In Europe, Valeo has selected the frequency of 868MHz in both directions for the prototype and the key is powerful enough to communicate with the vehicle over distances of more than 200 meters.

The 27 x 20mm screen (128 x 100pixels) can be black and white or color. The dimensions and the number of pixels can be adjusted, as can the functions controlled by the key. By way of example, data can be exchanged between two keys in order to synchronize them. The smart key can also be used as a USB storage device with a capacity of 1GB, which can be increased to 4GB with the built-in µSD card.

## Smart car key benefits

### Benefits for the carmaker

- Technological image thanks to the new functions that can be remotely controlled using the smart key.
- Possibility to customize the key with the carmaker's brand, which gives the device a high-profile identity.
- Modular design offering different levels of functionality and design.

### Benefits for the user

- Permanent access to the vehicle data in order to check the vehicle remotely.
- Possibility of using functions over long distances.
- Possibility of transferring data from a computer.
- Easy-to-use design for simple and intuitive navigation.



# Compact Spindle Drive: an electric telescopic actuator for trunks and tailgates

Valeo's electric telescopic actuator improves safety and comfort and can easily replace existing opening systems

## Increased comfort

Motorists are increasingly sensitive to the ease of use of their vehicles. Handling trunks and tailgates can be difficult if they are heavy or if they rise too far on opening.

## A promising alternative

Valeo's Compact Spindle (electric telescopic actuator) offers real benefits over gas-operated spring systems when loading, while requiring no major changes to the vehicle. Valeo already offers a range of power closure systems for trunks and tailgates. On the strength of this experience, Valeo has been able to develop a very compact electric tailgate actuator that is installed in the drip rails on either side of the vehicle, without reducing visibility or trunk volume. The two actuators are synchronized by control software to ensure smooth, quiet movement and reduce mechanical stress. The Compact Spindle is available as an option and can be installed alongside a manual system.

## Operating principle

The Valeo Compact Spindle is driven by an electric motor through a gearbox and a spindle which converts the rotary movement into linear motion. Travel can reach 250mm, a distance that suits most trunks and tailgates on the market. The actuators are very powerful, generating, for example, 700N at a speed of 30mm/s. An internal compensation spring reduces the power that the motor has to provide for optimal balance of the tailgate. The spring is very carefully rated so that the spindle can support the tailgate in any position without electric power, even when the vehicle is on a slope. The system also allows the panel to be opened manually.

An actuator is installed on either side of the vehicle. The speed of each actuator is regulated by a controller managed by software that determines the direction, position and speed of movement of the tailgate. This program is designed to:

- guarantee smooth and continuous movement under all circumstances,
- prevent any torsional stress from being applied to the tailgate as the result of unsynchronized movement,
- detect any obstacles to prevent pinching or damage to the bodywork.

Safety can also be improved by installing touch-sensitive sensors on the tailgate or the chassis.



## Telescopic actuator benefits

### Benefits for the carmaker

- Interchangeability: the Compact Spindle can easily replace a gas-based devices as an option on a given model.
- Installation in the drip rails reduces the need for changes to the vehicle and allows easy integration on the assembly line.
- No bodywork reinforcements are necessary. The geometric definition of the interface parts is the same as for vehicles without the system.
- Top-quality design and finish.

### Benefits for the user

- With the Compact Spindle, trunks and tailgates can be opened effortlessly, even on slopes, making it easier to load the vehicle.
- The automatic closing system is quieter and safer.
- The tailgate can be held in all intermediate positions. The system is equipped with an anti-pinch device.
- The system does not reduce visibility or trunk volume.
- Trunks and tailgates can still be closed manually.



# Safe4U™ front-end module

Valeo has designed an innovative front-end module, setting a new standard for pedestrian protection

## Cars that respect pedestrians

Following on logically from technologies that have delivered far greater safety for vehicle occupants, cars must now provide the best possible protection for pedestrians in the event of a collision. This task falls to the front part of the vehicle - the front end module, which also contributes to weight reduction, fuel savings and perceived quality.

## Description of the active system

As a global supplier of front-end modules, Valeo has designed Safe4U™, with a minimum configuration including heat exchangers, lighting, bumper and impact assembly, sensors and detection systems. Safe4U™ rests on a structure that can be in steel, aluminum, plastic, or even a hybrid material. Valeo has perfected its use of these technologies, which are already in production for its customers all over the world.

The Optibumper architecture optimizes the passive protection of passengers and pedestrians. Two crosspieces in the front-end module are designed to absorb the energy from any pedestrian collision. The upper crosspiece is in malleable steel, supporting absorbers in compressible plastic. The system reduces the risk of injury to the pedestrian's legs and knees. The crosspiece is attached to two innovative, Valeo-designed «crash boxes» which are not in steel, but in plastic which offers the same compression as steel, but is more compact and easier to manufacture. Optibumper allows auto-makers to meet the new European standard 2003/102/EC, Pedestrian Impact Phase 2, which comes into force in 2010, and the US standards IIHS and the Allianz test. The efficiency of the concept enabled Optibumper to score maximum points in the «pedestrian impact» section of the EuroNCAP test.

In addition, Valeo offers an active system that increases protection of the upper legs of adults and the heads of children. This concept includes a pedestrian detection system that is linked to the active system that increases energy absorption, reducing the force of the impact and any injury to the pedestrian. If a collision is detected, the upper crosspiece comes away from its supports to slide back more easily, leading to a reduction of around 20 to 40% in pedestrian injuries.

## Description of the active system

Safe4U™ is a unique, active system developed at the front-end module division by Valeo engineers specialized in the Driving Assistance Domain. Pedestrians are detected by a radar on the upper crosspiece and two cameras along the radiator grill. The system can distinguish pedestrians from other hazards. Once it has established the risk of collision, two actuators release the upper crosspiece from its supports in under 100 milliseconds. This allows the upper part of the front end to swing back, limiting the maximum effort and spreading it over a longer distance, while optimizing the deformation of the crosspiece. The system is reversible: if the impact does not take place, the actuators move back into place and reconstitute the front end.

The individual parts of Optibumper are 1.5kg lighter (2.5kg for the whole vehicle) and the frame overhang is 60 millimeters shorter than a standard system. Optibumper's design leaves the finished product with considerable perceived quality, respecting styling with its zero play.

The active front-end module Safe4U™ combines specialist expertise in many different fields: front-end and impact protection architecture, detection electronics and pedestrian identification, lighting, cooling, safety, and actuators. Valeo is responsible for the entire development of the product, from digital design to validation and delivery, while respecting customer's deadline. Safe4U™ offers carmakers a technologically advanced product that helps to make vehicles that are lighter, cheaper to repair, and offer optimal pedestrian protection.

## Safe4U™ benefits

### Benefits for the carmaker

- Meets the new European standard, Pedestrian Impact Phase 2, and the American standard IIHS.
- Offers the highest level of protection possible in the EuroNCAP pedestrian impact test.
- Provides a weight gain of 1.5kg (2.5kg for the whole vehicle) and saves 60mm of frame overhang.
- Active system equates to unparalleled level of protection.
- Represents Valeo's global solution for carmakers, from design to delivery.

### Benefits for the user

- Lighter weight leads to fuel savings and reduced CO<sub>2</sub> emissions.
- Lower repair costs.
- A level of pedestrian protection not reached until now (active system).
- Reversible system (active system) with no impact on vehicle handling.

# Xenon lighting

Xenon lighting is the only technology currently available that is capable of improving night vision on a large number of vehicles

## The need to improve night lighting

Visibility is an essential part of road safety. So it comes as no surprise that the accident rate (the number of accidents compared with the number of vehicles on the road) is higher at night. In fact, statistics indicate that it is three times higher. And as people age, average visual acuity and resistance to fatigue when driving at night both drop. It is therefore vital to use the best available lighting technology.

## Xenon lighting increases visibility by 30%

Xenon lights stand out for their exceptional efficiency. Xenon low-beam lights effectively illuminate the road for 110 meters, compared with 80 meters for traditional technologies: an increase of more than 30%. At 110km/h, these additional 30 meters of illuminated road give drivers one extra second to react to an obstacle. And Xenon bending lights offer a gain in visibility of 44%.

A study conducted in Germany in 2007 by TÜV Rheinland looked at the correlation between the probability of having an accident at night (as opposed to during the day) on the one hand and at the Xenon take-up rate for the vehicle type on the other. The results speak for themselves. The number of fatalities on German roads could be reduced by 18% if all cars were equipped with Xenon lights. This kind of light could probably save as many lives as ESC, the electronic stability control system. Not only are they more powerful, but Xenon lights produce a light that is close to natural daylight. The same TÜV survey concluded that Xenon lights could prevent 60% of accidents that happen at night on country roads.

Moreover, Xenon lights are one of the few accessories that improve safety, consumption and greenhouse gas emissions. Because they consume less electricity, they cut fuel consumption by up to 0.05 l/100 km and reduce CO<sub>2</sub> emissions by 1.3g/km (figures taken from a CLEPA press release published in September 2007).

Finally, the visible presence of a lens and the bluish light produced by Xenon bulbs provide stylists with plenty of freedom for creative expression.

## Operating principle

Xenon lights are made of two electrodes enclosed in a bulb containing high-pressure Xenon, metal salts and halides. The originality of this technology is that the light source is not created by heating a filament, but by an electric arc between the two electrodes. A high voltage generated by ballast is needed to create the arc. The same principle is used to ignite neon strip lights.

Once the arc has been created, the voltage of the ballast is maintained at 85 V. This filament-free technology means that Xenon bulbs are capable of lasting as long as the vehicle.





## Xenon light benefits

### Benefits for the carmaker

- Possibility of offering their customers the best lighting technique that is currently available on a large scale.
- Hi-tech image of the front end of the vehicle.
- Greater styling possibilities.

### Benefits for the user

- Better lighting that reduces the risk of an accident:
  - Lighting distance of 110 meters, compared with 80 meters with low-beam lights, which gives drivers one extra second to react at 110 km/h,
  - Visibility gains of at least 44% with Xenon bending lights.
- A light that is close to natural daylight and is easier on the eye.
- Fuel consumption cut by up to 0.05 l/100 km, which represents 1.3 g/km of CO<sub>2</sub>.
- The bulbs last as long as the car.



# Camera-assisted adaptive high-beam lights

Drivers can enjoy ideal night-time lighting under all circumstances, and without dazzling oncoming traffic

## The misuse of high-beam lights

It is always preferable to switch on the high-beam lights for optimal visibility when driving at night. But drivers have to dip their lights every time they meet an oncoming vehicle, and then switch back to full-beam, once the other vehicle is no longer in their line of sight. Tired of constantly having to switch between low- and full-beam, many drivers do not make sufficient use of their full-beam lights. But good night-time vision is crucial for safe driving. Statistics show that an accident is three times more likely to occur at night than during the day, but this figure could be greatly reduced by the arrival of innovative technologies such as camera-assisted lighting.

## New lighting assistance technologies

As a start, Valeo proposes the BeamAtic® function in response to drivers' reticence to switch on their full-beam lights as soon as possible. BeamAtic® automatically controls the low- and full-beam lights, depending on whether there is an oncoming vehicle or a vehicle in front. Other vehicles are detected by a camera that scans the road in front of the car. A field study conducted by Valeo showed that with the BeamAtic® system, the use of full-beam lights was multiplied five-fold.

The BeamAtic® Plus function represents Valeo's second-level of lighting assistance technology, using camera-assisted adaptive high-beam lights. This system replaces low- and high-beam lights with a single light beam that varies gradually and continuously between two positions. Drivers benefit from ideal night-time lighting without dazzling oncoming traffic. The adaptive high-beam lights control both the distance and shape of the light beam. By way of example, when facing another vehicle in a right-hand drive car, the zone illuminated by the lights on the left-hand side is reduced more quickly than the zone on the right. Compared with a conventional system, in which the driver immediately dips the headlights, the camera-assisted lights provide the motorist with deeper lighting in transitional phases, without dazzling oncoming traffic and drastically reducing the «black hole» effect.

Valeo has also developed a further extension of this technology: the BeamAtic® Premium function. This system keeps the high-beam lights on at all times and only blanks out the zones in which oncoming or preceding vehicles are located.

Valeo already offers smart lighting solutions, including dynamic bending light (DBL) or low-beams for highways which can increase the length of the beam by 60 meters. The camera-assisted system also takes into account changes in road level, so that the beam is raised when approaching an upward section of road or is lowered when approaching a descent. The system also optimizes the range of the headlights without dazzling other road users.

Valeo's expertise goes beyond the development of lighting modules, enabling the company to offer new solutions to its customers. By way of example, Valeo conducts consumer surveys in order to provide carmakers with as much information as possible on the expectations of their customers, so that they can choose the best available technology.



## Operating principle

All of the adaptive functions are made possible by the CMOS camera that scans the road. Placed behind the windshield, close to the rear view mirror, this camera detects the different light flows. Image processing software then determines whether the light source is from a moving vehicle or a fixed light source, such as a street light or an information panel. The position of other vehicles is precisely determined in order to avoid dazzling the drivers.

In the BeamAtic® Plus function, the lighting distance and the shape of the beam are adjusted by the three motors in the lighting module.

## Camera-assisted high-beam light benefits

### Benefits for the carmaker

- BeamAtic®, BeamAtic® Plus and BeamAtic® Premium technologies are all visible to users.
- The exterior dimensions of the headlamps remain unchanged.
- The safety image of the model is enhanced by the inclusion of new lighting technologies.
- The camera can also be used by other functions.
- In the event of a fault, the lighting returns automatically to the conventional low beam mode.

### Benefits for the user

- BeamAtic® Plus and BeamAtic® Premium provide optimal lighting without dazzling other motorists.
- BeamAtic® multiplies the use of high-beam lights by five.
- Better lighting reduces the risk of an accident.



# MicroOptics™ technology

MicroOptics™ provides an even, progressive and three-dimensional illuminated surface

## A quest for identity

The multitude of regulations that govern the automotive industry tend to result in a standardization of vehicle styling. But customers want individual products, with their own image and character, that correspond to the owner's personality. Front and rear lights can give a car an identity and should be more than a simple light source.

## A 3D light source

Valeo is the first automotive supplier to offer variable-brightness lights. Valeo's MicroOptics™ technology is capable of emitting a fully configurable light source onto a surface. By way of example, the light from just a few LEDs can be evenly distributed across a large area, such as the rear lights. It is also possible to produce shading effects that give the lights a 3D appearance. For example, a red line provides the regulatory lighting, while the rest of the surface is covered with a multitude of openings that produce the 3D effect.

MicroOptics™ technology also offers new possibilities for vehicle customization that meet current regulations. It offers new possibilities to stylists, who can create a different appearance at day and at night. A range of colors can be associated, from white to orange or red. This technology can be applied to interior lights and to front and rear exterior lights, even if they have complex shapes.

MicroOptics™ also benefits from the advantages of LED technology. LEDs are compact and reliable; they consume very little power and last as long as the vehicle itself.

This Valeo technology is already applied to the rear lights of the Volvo XC60. Automakers are currently incorporating the MicroOptics™ process in several design projects.

## Operating principle

MicroOptics™ uses light guide technology to distribute the light source to a multitude of openings. These guides create a 3D effect with a very compact and thin optical unit. They use Flex Board technology LEDs or, for a lower price, LEDs that are mounted on a standard two-dimension electronic board.

The MicroOptics™ homogenous light guide technology has now become reality, using a CAD tool developed in-house by Valeo.

## MicroOptics™ benefits

### Benefits for the carmaker

- Greater creative freedom for stylists.
- Possibility of creating uniform light surfaces, or surfaces with gradual changes in light or color.
- Reduced number of light sources.
- Compact and thin lights that can be easily integrated.
- Low power consumption, resulting in reduced fuel consumption and CO<sub>2</sub> emissions.
- Compatible with power supplies ranging from 9 to 16 Volts.

### Benefits for the user

- An individual and distinctive style.
- A high-profile appearance.
- LEDs that last as long as the vehicle, with no maintenance.

# LED daytime running lights

Valeo's LED daytime running lights provide fuel savings of 0.2 liters per 100km compared with low beams

## Improved safety and energy savings

Daytime lights offer undeniable benefits by allowing drivers to spot other vehicles more quickly and more distinctly. Their use will be mandatory in all light vehicles throughout Europe from 2011 onwards. Low-beam lights, which could be used for the same purpose, are designed for night vision and are far too powerful for daytime use. Intensive use of the low-beam lights would increase fuel consumption and shorten the lifetime of the bulbs.

## A dedicated function

Valeo has developed a dedicated function that uses Light Emitting Diodes, or LEDs for daytime use. LED daytime lights require no maintenance throughout the vehicle's lifetime and their reduced power requirements cuts fuel consumption by about 0.2 l/100 km. The recent Audi A5 is fitted with a Valeo daytime lighting system made up of nine LEDs, installed at the base of the front optical units.

## Operating principle

The LEDs used for daytime lighting consume just 10 to 20W, compared with the 200W consumed by current low-beam lights using H4 bulbs. This significant reduction in power consumption leads to fuel savings of about 0.2 l/100 km.

LEDs last four times longer than H4 bulbs, and as long as the vehicle itself, making them ideally suited to intensive use.

## LED daytime running light benefits

### Benefits for the carmaker

- Reduced fuel consumption and CO<sub>2</sub> emissions.
- The design of the LEDs and their easy installation leaves the designer plenty of freedom.
- They give the vehicle a high-tech image.

### Benefits for the user

- Vehicles are more visible for other road users during the day.
- Very low consumption of electricity compared with low-beam lights, resulting in fuel savings of almost 0.2 l/100 km.
- Much longer-lasting than conventional bulbs.
- Customization of the vehicle.

# Low-speed maneuvering aids

A broad range of smart aids for low-speed driving is available to make maneuvering easier and safer

## Visibility restrictions

A number of driving situations exist in which visibility is a problem. Very often, it is impossible to see obstacles when maneuvering. Driving in parking lots, reversing into a parking space and leaving a diagonal parking space are all risky situations. The difficulties encountered in these situations are sometimes made worse by the limited rear visibility of certain vehicles and the current trend of using concrete or stone blocks that are below the level of the car windows. This problem is all the more serious for an increasing number of older drivers, who may find it difficult to perceive quickly all the obstacles around their vehicle.

## Innovative and useful aids

Many cars are now equipped with parking aids. The most common systems emit audible signals that increase in frequency as the vehicle approaches an obstacle. The signal sounds continuously when the vehicle is about 30 centimeters from the obstacle, although this distance varies from one carmaker to another. Obstacles are detected by several ultrasonic sensors installed across the width of the vehicle. While the distance data may be precise and easy to understand, the driver still does not know exactly where the obstacle is. Wide-angle video technology provides a clear view of the vehicle's environment, but cannot indicate precise distances. Valeo has succeeded in combining these two sources of information in order to make the most of both technologies. Drivers have a screen that also displays information on the distance from obstacles. This data can be displayed in various formats, depending on the carmaker's specifications. These signals are superimposed on the image filmed by the camera, in the zone where an obstacle has been detected. By way of example, as a vehicle reverses towards a column, a series of colored bars is displayed on the screen. The number of bars depends on the distance from the column.

When vehicles are parked facing forward in a diagonal parking space, it is sometimes difficult for the driver to see other cars when backing out onto the road. Valeo offers a system that is capable of detecting other vehicles approaching the car as it reverses out of its diagonal parking space. This function uses radars installed in the rear bumpers on each side of the car. These radars are already present if the car is equipped with Valeo's blind spot detection system. Even if the visibility is reduced, drivers are informed whether the road behind them is clear or if a vehicle is approaching.

Parallel parking is another tricky maneuver. The Park4U™ system automatically performs this operation in just a few seconds by controlling the vehicle's steering, while the driver controls the vehicle's speed and braking. The simple process of finding a parking slot begins by pressing the Park4U™ button. Side sensors scan both sides of the street and measure the length of empty parking slots. When a sufficiently large space is detected, i.e. the vehicle length plus 1 meter, the driver is informed by a visual indicator. When searching for a parking slot, the speed must not exceed 30kph and the distance between the vehicle and parked vehicles must be between 50 and 150 centimeters. The side of the vehicle can be selected using the indicator control. The driver then proceeds until the «Start Position» is displayed, at which point he or she can engage reverse and control the vehicle's speed using the accelerator and brake pedals. Park4U™ controls the steering wheel until the vehicle is safely parked. The maneuver can be momentarily interrupted. The parking sensors also inform the driver of any obstacles that may be in the vehicle's way. The vehicle speed must not exceed 7kph during the parking maneuver. If the vehicle is not correctly aligned, a complex calculation is used to move the vehicle backward and forward until it is ideally positioned. Park4U™ is compatible with manual and automatic gearboxes. It is currently available on the Volkswagen Touran, Passat, and Tiguan models. A later version will also be capable of driving the vehicle out of its parking slot by measuring the position of any obstacles when starting.



Perfect visibility all around the vehicle also makes for improved safety. Valeo's TopVue system is capable of displaying a vertical peripheral view, to a depth of several meters on a single screen. This system makes for easier and safer vehicle maneuvers at low speed, in places where the numerous obstacles are not always visible (e.g., posts or low walls, pedestrians, animals or simply a pavement when parking). The TopVue system has five cameras: one at the rear, one on either side on the rear view mirrors and two at the front. The two cameras at the front, positioned on either side of the vehicle, offer clear visibility under difficult conditions, such as low sunlight.

## Operating principle

A leader in all three sensor technologies (camera, ultrasonic and radar), Valeo prefers to use color CMOS cameras in order to produce images that allow the situation to be clearly perceived. The diagonal park assist system uses narrow-band 24GHz radars that comply with future regulations that will come into force in 2013.

Park4U™ uses only ultrasonic sensors. In addition to the four sensors installed at the front and the rear for the park assist function, two further sensors are positioned on either side of the front of the vehicle in order to detect the available space. The detection of a sufficiently high sidewalk determines the amplitude required to make the maneuver. If there is no sidewalk, the control unit calculates a trajectory in which the roadside depth aligns the vehicle with the vehicle parked in front of it. Park4U™ works in association with an electric power steering system and communicates with the vehicle's other electronic systems via a high-speed CAN bus. For safety reasons, the system cannot be activated if the vehicle's Electronic Stability Program (ESP) is deactivated or a trailer is hitched to the vehicle.

## Low-speed maneuvering benefits

### Benefits for the carmaker

- There is strong market demand for low-speed maneuver assist systems.
- These technologies are visible to the motorist.
- They offer a positive image and demonstrate that carmakers are preoccupied by the problems that drivers face.
- The ultrasonic, radar and camera sensor technologies have been tried and tested.
- Park4U™ relies on affordable components. It requires just two additional sensors, a push-button and an upgrade of the Control Unit if the vehicle is already fitted with a Valeo Park Assist System.

### Benefits for the user

- Easier to drive at low speeds.
- Improved safety at low speeds.
- Technologies that are easy to understand and use.
- Improved safety for drivers, pedestrians and other vehicles.
- Non-intrusive technologies. The driver stays in control.
- Park4U™: a solution for the most difficult parking maneuvers.
- Park4U™ offers good quality for money.





# Blind spot detection

Blind spot detection - an innovative new function to enhance active safety during lane changes

## Fast, reliable lateral surveillance

Changing lanes can be difficult for motorists, driving among other vehicles moving at different speeds. They are also hampered by a «blind» spot, an area of poor visibility between their lateral field of vision and the zone covered by the rearview mirror. Valeo's system alerts drivers to the presence of another vehicle in the blind spot. Additional information gives the driver an edge when performing a risky lane change.

Two radar sensors on either side of the rear of the car detect any obstacles. When one senses the presence of another vehicle - car, truck, or motorcycle - the system alerts the driver with a light appropriately situated in the wing mirror. This safety information is immediate and intuitive.

Valeo's blind spot detection is available on several General Motors brands, including Cadillac and Buick, Chevrolet, GMC, and is also fitted on the new Jaguar XF. The usefulness of this new Valeo system was recognized by a prestigious PACE Award in 2007.

## Operating principle

The radar emits millimetric waves of 24GHz and sweeps an area with a radius of 8 meters across a field of view of 150° between the front and rear of the vehicle. Only part of this area is programmed for use by the blind spot detection system, according to the requirements of the model and the automaker. The radar has no moving parts and is fully electronic, providing it with lasting reliability. The millimetric wave technology can be used in most weather conditions. The radar's narrow 200MHz bandwidth, allows it to be used all over the world.

The radar sensors are most easily fitted behind the bumper fascia. Since they can be fitted behind non-metallic parts, they do not impact the vehicle's styling.

The radar sensors can establish the precise position of all obstacles in the adjacent lane, and this information is then analyzed by an algorithmic program to determine the presence of an obstacle, its speed and direction. These sensors distinguish between moving targets and oncoming or parked vehicles. This gives the driver accurate and meaningful information on which to base informed decisions about changing lanes.



## The benefits of blind spot detection

### Advantages for the automaker

- The narrow frequency band at 24GHz is authorized in all countries.
- The radar functions whatever the speed of the vehicle.
- It can be used in most weather conditions.
- The system does not impact the vehicle's styling since it can function beneath a non-metallic skin.
- The area covered by the radar is much greater than the blind spot itself, which means that it is covered in most conditions.

### Benefits for the user

- With the reliable information from the blind spot detection system, the driver can change lane safely.
- The presence of a vehicle in the blind spot is indicated immediately and intuitively.
- Even in severe weather, the driver therefore has valuable assistance.
- The radar can detect cars, trucks and motorcycles down to 250cc.
- Both sides of the vehicle are monitored.



# Flat Blade 2 wiper blades

The second generation of Valeo Flat Blades offers greater visibility, even under the most difficult conditions

## Improved wiping

The large three-dimensional windshields of modern vehicles can often cause problems of visibility for motorists. The wiper blades are longer than ever and the multitude of articulated levers is insufficient to press the blade uniformly against the windshield at high speeds or when driving in foul weather.

## Flat Blade 2 optimizes contact with the windshield

The travel of the wiper blade must follow the curved, three-dimensional shape of the windshield, while applying sufficient pressure, along the entire length of the blade, to expel the water.

Flat Blade 2 features a single spline that is built into the blade and a hard rubber spoiler. This concept distributes the pressure across the entire surface of the blade more evenly than wiper arms with articulated levers. The wiping capacity is increased under all circumstances, especially up to 220kph, and the accumulation of snow on the blade is reduced. Flat Blade 2 models are available in lengths ranging from 350 to 700mm, which cover most of the market.

## Operating principle

The aerodynamic flow applied to the wiper blade deflector is determined by the vehicle speed and the positive or negative wind speed. This observation explains why it is so important to increase the limit at which the blade lifts from the windshield. In order to achieve sufficient contact pressure between the blade and the windshield up to air flow speeds of 220kph, Valeo separated the spoiler from the blade, changed its shape and made it using rubber that is more rigid than the rubber used to make the blade. These aerodynamic improvements also apply to the lower part of the blade, which was changed to avoid the generation of positive lift.

The single built-in spline reduces the width, while improving visibility and reducing the risk of the accumulation of snow, thanks to the reduced volume beneath the spline. Another critical point is that the wiping capacity remains optimal right up to the ends of the blades. This development is significant, especially in view of the increase in the height of windshields, which now require a greater wipe radius.

The blade is also 50% lighter than blades with traditional wiper arms. A 600mm Flat Blade weighs just 101grams!

## Flat Blade 2 benefits

### Benefits for the carmaker

- The new conception of Flat Blade 2 offers a more harmonious design.
- The wiping limits have been pushed back, with a maximum air flow of 220kph.
- Flat Blade 2 is lighter and more compact.
- Flat Blade 2 is made entirely of recyclable materials.

### Benefits for the user

- Improved visibility, thanks to the reduced width of the blade and the increased wiping radius.
- Reduced risk of snow accumulating on the blade.
- A better wipe at high speeds, thanks to the optimized spoiler.



# Post-equipment: offering Valeo technologies to every vehicle

Valeo Service sells a broad selection of high-performance products and services (catalogs, marketing tools, training, diagnostic tools) for dealerships, spare parts distributors and independent repairers in more than 100 countries worldwide. Valeo Service accounts for 18% of the Group's sales.

Motorists can now add innovative post-equipment solutions to their vehicle themselves for an enhanced driving experience.

## **Beep&park/vision™**

**Beep&park vision™ combines the functions of a camera and a reversing radar in order to make parking even easier. All obstacles can be detected and viewed.**

## **Guidéo**

**This solution consists of a camera attached to the interior rear view mirror that performs the following functions: lane alert (accidental lane change), Optilane (trajectory correction), video box (video memory) and beep&watch (alert when the preceding vehicle starts up at traffic lights).**

## **Speed/visio**

**This system displays the vehicle speed on the windshield and warns drivers with an audible signal when they exceed the pre-set speed limit. Drivers are able to check their speed without taking their eyes off the road.**

## **Beep&park™**

A complete range of park assist systems. The on-board system's ultrasonic sensors detect obstacles at the front and rear (vehicles, posts, pedestrians, etc.) and inform the driver by emitting a sound signal. Additional information, such as the distance from the obstacle and its precise position, is shown on the control screen positioned above the rearview mirror.

## **Beep&park/keeper™**

This unique park assist system protects your vehicle in two ways: when parking, by detecting obstacles, and when stationary, by warning other approaching drivers with visual and audible signals.

## **Park/vision™**

This park assist solution combines a camera, installed at the rear of the vehicle, and a detachable screen placed on the dashboard.

## **Light/on&off**

When the light levels drop, Light/on&off corrects any possible underestimation of the danger or the driver's forgetfulness by automatically switching on the lights. The system switches the lights on automatically when luminosity is less than 1,000 lux. The lights are automatically switched off as soon as the luminosity exceeds 3,000 lux.