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Audi Le Mans quattro

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Short copy

Unveiled in Frankfurt: the Audi Le Mans quattro

The genes of a winner

A high-performance sports car, a roadgoing vehicle that could be said to have inherited the genes of the Audi R8, three-times winner of the Le Mans 24-Hours race: Audi reveals its 'Le Mans quattro' concept study.

This fascinating driving machine is a synthesis of the experience gained from numerous racing triumphs, allied to advanced design and Audi's technical competence - which has in turn become synonymous for Audi's technological leadership (Vorsprung durch Technik) on the racetrack and the road alike.

Even the first glimpse of the car gives the observer a clear picture of its calibre. The Audi Le Mans quattro, with its Jet Blue paint finish, has a wide stance and a bullish appearance on the road. Its powerful rear end seems to be bracing its muscles in order to jump, like a sprinter on the starting line. The car's front end and the broad curve of the roof seem to have been drafted with a single stroke of the pen.

1.90 metres wide but only 4.37 metres long and 1.25 metres high: this clearly reflects the proportions of a pure sports car. A wheelbase of 2.65 metres accommodates a surprisingly spacious cockpit and the longitudinally installed V10 'biturbo' engine with FSI direct fuel injection behind it. To the rear of the doors, between the sill and the roof, there is a large outward-curving intake that supplies the V10 engine, the brakes, the oil cooler and the charge-air intercooler with sufficient air.

The trapezoidal shape of the Audi single-frame grille is a distinctive feature of the front end, flanked on the right and left by additional large air inlets. Their upper ends are flush with the flat-strip LED headlights, which have clear-glass covers. The centre of the bonnet curves up above the line of the front wings, which spread out at the sides over the large round wheel arches typical of an Audi.

The cockpit architecture, which is oriented consistently to the driver's needs, dominates the car's interior. The driving position is integrated into the space between the instrument panel with its changeover display graphics and the centre console. However, the Audi Le Mans quattro car offers generous interior space for both occupants - a quality feature that clearly distinguishes it from other high-performance sports cars. The impression of perfect functionality and ergonomics is combined with materials of visible high quality and craftsmanship.

An aluminium Audi Space Frame (ASF) forms the central structure of this concept study. The outer skin and add-on parts use a weight-saving mixed aluminium and carbon-fibre concept - thus satisfying the demand for utmost rigidity at a simultaneously low weight of 1530 kg, and providing a foundation for top road dynamics.

This mid-engined two-seater is powered by a five-litre V10 'biturbo' engine with FSI direct fuel injection, developing 449 kW (610 bhp) at 6,800 rpm. Outstandingly free revving and considerable 'bite' are typical features of this engine, with its seemingly inexhaustible power reserves even at very low engine speeds.

The maximum torque of 750 Nm is available at an engine speed as low as 1,750 rpm and remains constant over a broad engine speed range up to 5,800 rpm. A sequential-shift six-speed sports gearbox enables the driver to use this powerful torque in the appropriate doses.

As a matter of course, any Audi as powerful as this will have quattro permanent four-wheel drive, which distributes the power variably - based on a 40:60 ratio - to the front and rear axles and thus gives this mid-engined sports car its optimum road dynamics. The Audi Le Mans quattro accelerates from 0 to 100 km/h in just 3.7 seconds and to 200 km/h in 10.8 seconds.

Double wishbone suspension is used at the front and rear. Firm basic suspension settings have been chosen to ensure the most effective road dynamics. Nevertheless, the innovative Audi 'magnetic ride' shock absorbers ensure a remarkably high level of ride comfort.

The Audi Le Mans quattro: a perfect synthesis of motor-sport technology and roadgoing car design. An automobile with the racetrack, the motorway and twisting country roads as its 'natural hunting grounds'.

Full copy

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This fascinating driving machine is a synthesis of the experience gained from numerous racing triumphs, allied to advanced design and Audi's technical competence - which has in turn become synonymous for Audi's technological leadership (Vorsprung durch Technik) on the racetrack and the road alike.

Audi has scored innumerable wins on racing circuits all over the world. After the successes achieved in rallying in the 1980s and many triumphs with touring cars bearing the four-ring emblem, Audi's commitment to sports-car racing represented undoubtedly the greatest challenge faced by its motor-sport engineers so far.

But here too the engineers mastered their task brilliantly: three times in succession - in 2000, 2001 and 2002 (and indeed taking first, second and third places in 2000 and 2002) - the Audi R8 cars were the first across the finishing line of the Le Mans 24-Hours race.

Le Mans - without doubt the toughest task that the Audi Sport Team's engineers have ever tackled. For this particular event all the car's systems have to be laid out to survive a distance far greater than in a short sprint event. This technological challenge includes - in addition to the essentials of top performance and optimum driving dynamics - endurance, reliability and perfect ergonomics.

These are virtues - and technologies - that can be translated with great effect into a roadgoing sports car and which make the Audi Le Mans quattro as unique as its thrilling design: the genes of a winner.

The exterior

Even the first glimpse of the car gives the observer a clear picture of its calibre. The Audi Le Mans quattro, with its Jet Blue paint finish, has a wide stance and a bullish appearance on the road. Its powerful rear end seems to be bracing its muscles in order to jump, like a sprinter on the starting line.

The body makes a compact impression. The car's front and the flat curve of the roof outline seem to have been sketched with a single sweeping stroke: a line that identifies the two-seater instantly as an Audi, since together with the front curve of the front wings it recalls the Audi TT and the Nuvolari quattro GT study.

Familiar contours at the sides too: both the dynamic, waisted line above the sill and the shoulder line link the car's front, sides and tail end together; the doors and the transition to the side air inlet are particularly well sculpted and emphasise the typical round Audi wheel arches with large 20-inch wheels in an even more intensive way.

The windscreen seems to grow directly out of the short front section. Its glass has been given a hydrophobic (water-repellent) coating - an achievement derived from nano-technology - which is also highly resistant to dirt. A similar micro-coating helps to reduce the penetration of ultraviolet and infrared rays and prevent the interior from heating up.

The Audi Le Mans quattro is a markedly 'cab forward' design, typical of a mid-engined sports car and with visible echoes of the Audi R8. Behind the occupant area but ahead of the rear axle is the V10 engine with its twin turbochargers: a technical sculpture that is visible from the inside of the car and also through a large, transparent rear flap.

1.90 metres wide but only 4.37 metres long and 1.25 metres high: those are the proportions of a supersport model. The 2.65 m long wheelbase accommodates a remarkably spacious occupant area and the longitudinally installed engine behind it. To the rear of the doors, between the sill and the roof, there is a large outward-

curving intake that supplies the V10 engine, the oil cooler, the charge-air intercooler and the brakes with sufficient air.

The trapezoidal shape of the Audi 'single-frame' grille is a distinctive feature of the front end, flanked on the right and left by additional large air inlets. Their upper ends are flush with the flat-strip LED headlights, which have clear-glass covers. The centre of the bonnet, carrying the four-ring badge, continues the dynamic line of the low central radiator grille typical of a sports car such as this. It curves up above the line of the front wings, which spread out at the sides over the large round wheel arches typical of an Audi.

LED - these three letters stand for "light-emitting diode" - a technology with confirmed advantages, such as a tenfold reduction in power consumption compared with conventional bulbs, but with a very much longer operating life.

Nor is that all - the LED principle has even more potential for future uses. In a later development stage, LED headlights will enable dynamic cornering beams to be provided by a system that does not use any moving parts. By switching additional LED elements on and off electronically, the light beam can be varied in width and direction.

Another LED advantage is that the lighting elements take up less room than conventional ones, so that the designers have more scope for exercising their talent. The 17 cooled light sources on each side are much closer to the transparent cover than is normally the case, and the covers too are of reduced size, so that the entire front end of the car looks more compact and tauter in its styling. The light-emitting diodes for the flashing turn indicators separate the two LED blocks used for the dipped and full headlight beams. The side turn indicator repeaters, housed in the base of the outside mirrors, also use this new technology.

Seen from the side, the rear-end contours consists of an interplay of concave and convex lines. Below the clearly defined spoiler lip is a shallow, vertical surface framed at the sides by the rear light assemblies, which also use LEDs. The light strip for the third brake light runs across the entire width of the roof at the rear end of the transparent engine cover.

The base of the rear end in particular exposes certain technical features of the Audi Le Mans quattro, among them the two central exhaust tailpipes and two large diffuser openings that reveal the intensive influence of aerodynamics on the car's design.

Body aerodynamics were developed in Audi's modern wind tunnel, in close cooperation between Audi Design and Audi Sport. These two sections of the Audi organisation have already worked on three generations of the Audi R8 competition car, preparing it for road speeds of well over 300 km/h and optimising its aerodynamic downforce for fast, safe cornering - technology transfer at the very highest level.

When the Audi Le Mans quattro is driven at a speed above 120 km/h, its rear spoiler is extended automatically into the slipstream, to add to the 'negative lift' generated by the aerodynamic design of the floor pan and the diffusers. If the driver wishes to leave the spoiler extended all the time, for instance when lapping a racing circuit, it can be prevented from retracting at a button on the multifunctional steering wheel. Otherwise it moves back in again flush with the body when the Audi Le Mans quattro's speed drops below 80 km/h. Incidentally, the spoiler is also extended when the car is reversed, since it contains the strip-pattern reversing lights.

This concept car is based on aluminium Audi Space Frame (ASF) structure - the perfect blend of minimum weight and maximum rigidity as a foundation for the highest standards of road dynamics.

The outer skin of the body and various add-on parts are of mixed weight-saving construction, using aluminium and carbon-fibre reinforced plastics. This is a precondition for the car's low gross weight of only 1,530 kilograms and therefore for its outstandingly good power-to-weight ratio of only 2.5 kg/bhp.

When the large covers are electrically released and opened, the elaborate suspension elements and the wide tyres with their precision tread pattern are revealed.

The interior

The systematically driver-oriented architecture dominates the car's interior. The driver can be regarded as an integral element of a cockpit bordered by the fascia, a high centre console and the instrument panel above it, which is angled towards the driver.

Form follows function: the Audi Le Mans quattro pursues this approach with great determination. In addition to the driver-oriented interior architecture, which continues in the design of the door cappings, it is the choice of materials that creates the functional atmosphere. A critical look from the driving seat confirms that in this 'driving machine' the design and positioning of all the elements have been concentrated on essentials.

Even the contribution made by the colour scheme to the overall ambience pursues the same aesthetic and ergonomic purpose: dark, 'technical' shades also create a visual link with motor sport, and the impression of professional functionality and ergonomic efficiency is borne out by the prominent use of top-quality materials and workmanship.

The footwells and footrests are fully painted to yield a surface finish that is repeated inside the boot and the engine compartment as well.

Individual areas are clearly distinguished by the use of different materials: the fascia, for instance, uses a high-grade semi-transparent woven material with a network structure; this is also to be found on the outside of the seat shells. For precision operation and to make them pleasant to the touch, the controls are of rubber and aluminium.

A non-slip material with the appearance of Neoprene is used for the shoulder area of the seat shells. These are hinged in the lumbar region and have the seat cushions upholstered with a sporty and futuristic high-tech weave. Four-point automatic-reel seat belts restrain the wearer's body effectively even at the high rates of retardation encountered on the racing circuit.

The amount of space provided ensures a high standard of ride comfort for the occupants - easily superior to what is normally available in a high-performance sports car.

There are well-positioned storage shelves in the cockpit and removable pouches behind the seat shells, which can be folded forwards. The front luggage compartment has a volume of 100 litres, enough to accommodate the weekend baggage of the car's two occupants.

All the main sources of information are directly in front of the driver, in the area behind the multifunctional sports steering wheel, the rim of which is flattened at the bottom. The instrument cluster is divided into three sections: the rectangular centre section flows in a droplet pattern into the information units at the left and right.

Whereas the revolution counter at the left, although operated digitally, has a classic circular dial, the interior designers have pursued an entirely new path for the right section of the instrument cluster. The large-format digital display uses the TFT technique and can be switched between three modes - analogue, track and MMI - by the driver.

When cruising, and in the *analogue mode*, the surface becomes a digital speedometer with an analogue display and an additional clock display.

Those who take the Le Mans quattro out on to the racing circuit can use the *track mode* to display a plan of the circuit. Information obtained by GPS is used to show the next bend and to compute the lap time. In parallel with this, the almost square central section displays information on the selected suspension settings and the gear in use.

The principal data on the engine's operating condition, for instance oil pressure and temperature, can be obtained in the *MMI mode*. For road use, this is where the route guidance pictograms supplied by the navigation system in the TFT display are shown.

The system is controlled from the MMI terminal, which is conveniently located on the centre console - an operating concept that has already proved convincing in the Audi A8 production car, thanks to its logically planned layout.

Another well-proven feature is operation of the sequential-shift sports gearbox by paddles behind the steering wheel. This ergonomic concept has long since proved successful in motor sport - the best example of this being the threefold Le Mans winner, the Audi R8.

The small-diameter sports steering wheel also resembles a racing-car design. There are four switches below the central impact-absorbing hub: one operates the spoiler, the next activates a 'pit stop' function. This makes it much easier for the driver to comply with speed-limited zones.

The third of these easily reached and operated buttons adjusts the shock absorber settings of the Audi magnetic ride system extremely rapidly. The fourth and last steering wheel button activates the track mode in the display.

The powertrain

A flow of power as if from a turbine, a high maximum torque curve and a fascinating sound: the basic features of a perfect sports-car engine. This 5.0-litre V10 engine with its twin turbochargers is just as fascinating in the potential it offers as in its suitability for day-to-day use. Its 'bite' in every operating range and its unrivalled willingness to rev up to high speeds are truly impressive.

An included angle of 90 degrees between the engine's cylinder banks helps to keep the entire car's centre of gravity low. It makes sensible use of the available space and does not obstruct the driver's view to the rear. A crankshaft with offset crankpins is used to ensure supreme refinement and a sporty sound.

This ten-cylinder engine has 40 valves, operated by four overhead camshafts. Both the inlet and exhaust valves have continuously variable opening periods to ensure optimum gas flow in all engine-speed ranges.

Two turbochargers driven from the exhaust and located behind the engine boost the pressure of the combustion air to a maximum of 2.0 bar before it is forced into the engine. The charge-air intercoolers are mounted above the engine. They are fed with air through an inlet on the body side and have an additional low-temperature cooling water circuit. The two oil coolers are at the side of the engine, well positioned in the airflow behind the side inlets.

As a result of these careful design measures, the engine can develop an impressive 449 kW (610 bhp). A big contribution to this formidable output is made by the direct petrol injection (FSI) system, which set new standards in the cars that won such historic victories in the 2001 and 2002 Le Mans races and in the American Le Mans Series. FSI combines outstandingly efficient power output with highly efficient combustion of the fuel.

In the Audi Le Mans quattro the ten-cylinder biturbo FSI engine is particularly pleasant on account of its willingness to rev freely and its lusty pulling power at all engine speeds. The maximum torque of 750 Newton-metres is available within an exceptionally broad engine-speed range from 1,750 to 5,800 rpm, so that unnecessarily frequent gear changes are avoided. With these basic output and torque data, the five-litre engine can catapult this two-seater car from a standstill to 100 km/h in only 3.7 seconds and continues to accelerate it until the speedometer needle reaches 200 km/h, which it does after a mere 10.8 seconds. The theoretical top speed is 345 km/h, but this is electronically governed to 250 km/h.

Despite this abundant flow of power, it is quite probable that the driver of the Audi Le Mans quattro will choose to change gear quite often at the manual selector paddles behind the steering wheel, since gear changes take only a fraction of a second and there is no clutch pedal to be operated. A short gear lever is mounted on the centre tunnel, next to the electronic parking brake control, but is used only to preselect the automatic, normal and sport modes and also to engage reverse gear.

Thanks to an electro-hydraulic system, the car can be driven away from a standstill without a clutch pedal having to be operated. In this way, the sequential-shift 6-speed gearbox offers the highest level of driver convenience as well as the dynamic gear changes expected of a sports car. The gear ratios are widely spaced, so that the driver always has the ideal gear available to make controlled use of the engine's monumental torque.

Such a powerful Audi car naturally features the quattro permanent four-wheel drive system. The Le Mans quattro, as a leading-edge technology carrier, has a version of this legendary driveline that has been adapted to suit the car's mid-engined layout and the associated axle-load distribution.

For optimal traction and dynamic road behaviour, the power from this mid-engined sports car's ten-cylinder engine is normally distributed in a ratio of 40:60 between the front and rear axles. This achieves maximum agility together with optimal traction - essentials for supreme road dynamics in all conditions and on corners of varying radii.

This version of the quattro driveline, with Torsen C inter-axle differential, is of course capable of diverting engine torque to the axle at which there is more tyre grip available, in order to suppress wheelspin. Depending on the amount of grip detected, torque distribution between the front and rear axles can be varied continuously from 20 : 80 to 70 : 30 percent.

Running gear

The suspension uses double wishbones at front and rear; the upper and lower front wishbones are both triangulated. At the rear, the upper wishbone is triangulated and the lower one is of a trapezoidal pattern for optimal wheel location - a geometry that has proved ideal for maximum steering precision and precisely defined self-steering effects in motor sport.

Direct-action rack and pinion steering with the degree of power assistance dependent on road speed reduces steering wheel effort while ensuring an optimal level of feedback from the road.

The spring and shock absorber settings are firm, to ensure the highest possible level of road dynamics, but the level of ride comfort that they offer is none the less most remarkable. This is because the shock absorbers feature an innovative technology known as 'Audi magnetic ride'. Instead of the conventional hydraulic fluid in the shock absorber, it contains a 'magneto-rheological' fluid, the viscosity of which can be varied by applying a magnetic field. The electronic control system energises an electromagnet which can be used at any time to influence the shock absorber's operating characteristic.

In this way the most suitable level of damping can be provided in every driving situation, for optimum ride quality and dynamic road behaviour. A computer uses signals from sensors to detect the actual driving situation within a few thousandths of a second. A switch is provided at the steering wheel for the driver to choose between two driving programmes, either an emphatically sporty one using the magneto-rheological shock absorber fluid at low viscosity, or the alternative setting for greater ride comfort.

The Audi Le Mans quattro has large-diameter, suitably impressive 20-inch wheels with seven double-arm styling. Front tyres of size 255/30 , with 295/30 tyres at the rear, keep this potent car anchored firmly to the road surface. These sizes also ensure that the dynamic talents of the powertrain and running gear are translated into optimal grip and the maximum possible lateral dynamic levels. And of course the design and dimensions of these wheels add even more to the characteristically sporty looks of the Audi Le Mans quattro.

The wheels are of the centre-lock type, with an absolute zero-play connection between wheel hub and stub axle to ensure accurate wheel location in all three dimensions and perfect dynamic balance. The wheel retaining nut has a built-in freewheel to prevent it from unscrewing accidentally - here too, technologies that had their origins in motor racing.

Yet another high-tech feature adopted from motor sport: the brake discs are made from a ceramic material. With diameters of 380 mm at the front and 356 mm at the rear, they slow and stop the car in a manner that matches its immense performance. Braking pressure is transmitted to these discs by eight-piston fixed calipers at the front and fist-type calipers at the rear.

The ceramic material used for the brake discs conducts heat away excellently, withstands high temperatures very well and is therefore exceptionally resistant to fading: a most desirable feature that will enable the Audi Le Mans quattro to achieve the fast lap times of which it is capable on the world's racing circuits.