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## **Audi R10**

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## Summary

### **Audi R10**

## **Audi competes with diesel sportscar at Le Mans**

**AUDI AG is once again one step ahead of the opposition: The inventor of 'TDI' will become the world's first automobile manufacturer to fight for overall victory with a diesel engine in the famous 24 Hours of Le Mans. The all-new Audi R10 is powered by a totally new 5.5-litre, twelve-cylinder bi-turbo TDI engine, which is extremely quiet and economical.**

The Le Mans Prototype, with over 650 hp and more than 1100 Newton metres torque, significantly exceeds the power produced by the majority of previous Audi racing cars – including that of its victorious R8 predecessor. Audi ventures into previously unexplored diesel-engine terrain with the V12 power plant manufactured completely from aluminium. As with the TFSI technology, which triumphed initially at Le Mans before being adopted for mass-production, Audi customers should benefit once again from the lessons learnt in motorsport.

“With the A8 4.2 TDI quattro, Audi already builds one of the most powerful diesel cars in the world,” explains Prof Dr Martin Winterkorn, Chairman of the Board of Management of AUDI AG. “The Le Mans project will help our technicians to extract even more from TDI technology. Nowadays, every second Audi is delivered with a TDI engine. We expect that the percentage of diesel engines will be even larger in the future.”

The R10 prototype's V12 power unit, which is equipped with two diesel particle filters, is hardly recognisable as a diesel thanks to the engine's smooth running nature. The TDI engine's specialities presented the Audi Sport engineers with a whole list of challenges. The injection pressure easily exceeds the 1600 bar achieved in production cars. The usable power band lies between 3000 and 5000 revs per minute – an unusually low rev range for a racing engine. The driver must change gear in the R10 far less often than in the R8 because of the TDI engine's favourable torque curve.

The enormous torque of over 1,100 Newton metres does not only make extreme demands of the R10 transmission system – even the latest generation of engine

dynamometers at Audi Sport had to be re-equipped with special gearboxes capable of withstanding the unusual forces.

Additionally, radical changes to the chassis were also necessary. The Audi R10 has a significantly longer wheel base than the R8. The overly wide front tyres, which, up until now, are unique for a Le Mans Prototype, will help to improve the handling. New technologies were also implemented during the development of the carbon-fibre monocoque. Chassis, engine and gearbox form an extremely rigid, fully stressed unit.

“The R10 project is the biggest challenge ever to have been handed to Audi Sport,” says Head of Audi Motorsport Dr Wolfgang Ullrich. “TDI technology has not been pushed to its limits in motorsport yet. We are the first to confront the challenge. The demands of such a project are accordingly high. Long-term technology partners such as Bosch, Michelin or Shell support us in our quest. Together we have the chance to write new chapters in the history books of motorsport and diesel technology.”

The new Audi R10 successfully completed its first test at the end of November. An extensive test programme, including the 12-hour race at Sebring (USA) on 18 March, is scheduled before the 24 Hours of Le Mans on 17/18 June 2006. The development team from Audi Sport is supported by Reinhold Joest’s squad, which also performed this task during the R8 project.

In detail

## **The engine**

### **V12 TDI made entirely from aluminium**

The heart of the Audi R10 is a completely new V12 TDI engine with a cubic capacity of 5.5 litres – the maximum permitted at Le Mans. Audi ventures into previously unexplored diesel-engine terrain with power exceeding 650 hp and torque of more than 1100 Newton metres from the V12 power plant. “This engine is the specifically most powerful diesel there is in the world and, up until now, the biggest challenge that Audi Sport has ever faced in its long history,” explains Ulrich Baretzky, Head of Engine Technology at Audi Sport. “There has never

been anything remotely comparable. We started development with a clean sheet of paper.”

The V12 TDI used in the R10 is the first Audi diesel engine with an aluminium crank case. The cylinder-bank angle is 90 degrees. The V12 TDI has, like Audi production car engines, four valves per cylinder and twin overhead camshafts. The fuel induction is made by a modern “Common Rail System”. The injection pressure easily exceeds the 1600 bar achieved in production cars. The ignition pressures also reach values never previously seen in any Audi engine.

The turbo pressure produced by the two Garrett turbochargers is limited by the regulations to 2.94 bars absolute, the diameter of both engine air intake restrictors, stipulated by the regulations, is 2 x 39.9 millimetres. The engine management is controlled by the latest generation of Bosch Motronic (MS14).

The engine’s power and the high torque are available to the driver practically from idling speed – a speciality of diesel technology, to which the Audi drivers must now become accustomed. The usable power band lies between 3000 and 5000 revs per minute.

Unfamiliar to the driver at this early stage, is the low noise level and, unique for a racing engine, the smooth running V12 TDI power unit. At high speeds the powerful 650 hp engine can not be heard from the Audi R10 prototype’s “open” cockpit while there is also hardly any vibration. On the outside, the modern twelve-cylinder produces a faint, but sonorous sound that quite possibly nobody would identify as a diesel power unit at first. The new R10 can only be recognised acoustically as a diesel-powered sportscar during the warming-up process or in the pit lane.

There are no visual signs that a diesel power unit is at work in the back of the R10. It goes without saying that the V12 TDI is equipped with a pair of diesel particle filters for the 24 Hours of Le Mans. Flashes of flame from the exhaust, which are created by unburned petrol in spark-ignition engines, are not seen coming from the R10.

One of the diesel engine’s biggest advantages is the low fuel consumption, especially at part-throttle and overrun. However, when compared to more classic circuits which demand a higher ratio of part throttle, the lower specific

consumption will hardly be noticeable at Le Mans because the quota of full-throttle is almost 75 percent.

The enormous torque of over 1,100 Newton metres not only posed previously unforeseen demands in the development of the R10 drive train. Even the latest generation of engine dynamometers at Audi Sport had to be reequipped with special gearboxes capable of withstanding the unusual forces.

Inside the V12 TDI, the extremely high pressures in particular create forces never seen before in a racing engine. However, the main target of the Audi technicians is to reach the reliability level of the R8, which never recorded a single engine failure in the 77 races it has contested to date.

## **The Chassis**

### **New design with Audi R8 genes**

At first glance, it is visible that the new Audi R10 carries genes from the extremely successful R8. Nevertheless, the new LM P1 sportscar's chassis is a new design, during which Audi Sport explored many new avenues. "The R8 originates from 1999, we've gathered a huge amount of know-how since then," says Wolfgang Appel, Head of Vehicle Technology at Audi Sport. "All this experience found its way into the new R10."

Audi's target with the sports-prototype – currently the world's most interesting motorsport category – is to set the standards once again and to highlight the company slogan "Vorsprung durch Technik". Numerous innovative details and new design principles are used in the new Audi R10.

One of the most significant differences to its predecessor, the R8, is the integration of monocoque and bodywork. The R8 still had a traditional chassis clothed in synthetic bodywork, whereas the majority of the carbon-fibre parts belonging to the R10 monocoque are now suspended directly in the air flow and therefore require no additional fairings.

This leads to a significant weight saving when compared with the R8, which is of particular importance since the dimensions of the 5.5 litre V12 TDI engine mated to the R10 make it longer and heavier than the 3.6 litre V8 power plant fitted to

the R8. That's why the new R10 has a significantly longer wheelbase than its predecessor, comparable incidentally, with the new Performance SUV Audi Q7.

The modular design and serviceability known from the R8 was retained, but further refined, in the basic concept. It is not only the rear bodywork section of the R10 that can be removed at the flick of a wrist, the front section, including crash structure, is also removable to ease access to the front suspension for the mechanics. It is possible to change the gearbox and its internals within a short space of time.

The R10's aerodynamic configuration is even more refined than that of the R8. Although the new LM P1 regulations created by the ACO (Automobile Club de l'Ouest) targeted a 15 per cent reduction in overall downforce, the Audi Sport technicians managed to regain the majority of aerodynamic efficiency lost as a result of this through intensive wind tunnel work. The R10 silhouette is five centimetres flatter than its predecessor and has a much more pointed nose.

The "steps" in the front splitter, the larger distance between the track and the side pods and the additional roll-over structure on the passenger side, which clearly distinguishes the R10 from its predecessor when viewed from the front, are stipulated by the regulations.

The bulk of the changes implemented by the rule makers were made to make the powerful sport-prototypes even safer. Included in this catalogue of changes is the use of the HANS-System (Head and Neck Support), familiar in Formula 1, that protects the driver's spine in the event of an accident.

Although the R10 prototype's carbon-fibre monocoque is more waisted than that of the R8, the drivers can sit comfortably in the cockpit – a factor not to be underestimated in a 24-hour race like at Le Mans. The servo steering, which is now electric instead of hydraulic, also helps to increase comfort.

A similar direction to that taken in production, was followed with the electronics. The number of electronic control units rose considerably when compared with the R8. A "network" system (CAN-Bus) runs through the entire R10, all important functions are controlled centrally by computers. Even the indicators and headlights are no longer directly activated by the driver, he simply makes a manual impulse – everything else is done by the on-board computers.

A new vehicle data logging system (FDE) was developed for the R10 together with electronic partner Bosch. All data is transmitted by telemetry to the pits and shown in the cockpit on a steering wheel mounted display, similar to the MMI-System found in Audi production cars. The most important functions are controlled by buttons mounted on the steering wheel, which is equipped with a micro-processor and was developed together with the specialist company Megaline.

The Megaline experts were also involved in the development of the electro-pneumatic shift mechanism, which is also activated in the R10 by two steering-wheel mounted paddles. The gearbox itself originates from X-trac and, despite the enormous torque produced by the TDI engine, is lighter than that of the R8.

Thanks to the turbo-diesel engine's characteristics the number of gear changes made during a 24-hour race falls significantly – an important factor concerning durability, particularly as the transmission system is subject to extremely high loads.

Because of the high level of torque produced by the V12 TDI, the forces acting on the R10 transmission system are even greater than those experienced by a Formula 1 racing car. The gearbox was conceived to withstand these forces as are the driveshafts which are thicker than the ones on the R8. The same is valid for the novel ceramic clutch that was developed together with ZF Sachs.

The greater thermal discharge and the corresponding increase in cooling requirements are also diesel specific. Higher side pods, in which the larger coolers are fitted, are the result. The wider front tyres, which were commissioned by tyre partner Michelin, are completely new to the LM P1 class. They should reduce the sport-prototype's inherent understeer tendency, which, in theory, is increased even further through the enormous thrust produced by the TDI engine. The use of traction control (ASR) reduces the high loads created by the torque fed to the rear tyres, and helps the driver to modulate the V12 TDI engine's power delivery, particularly in wet conditions, which represents a new dimension even for season campaigners. "It's impressive just how the engine keeps on pushing even in the high gears," says astonished three-time Le Mans winner Frank Biela, who was at the wheel of the R10 during the roll-out at the end of November.

The refuelling system re-developed with specialist company Stäubli, allows a fast and virtual splash-free refuelling process. In contrast to petrol, spilled diesel does not evaporate itself. As was the case with the R8, various coloured light-emitting diodes located close to the refuelling inlet vent act as initial visual information indicating the diesel, engine oil and water levels to the mechanics during a pit stop.

Fans at Le Mans will no longer be able to see glowing brake discs on the Audi R10: The carbon-fibre brake discs are fully enclosed in a cowling, similar to the Audi A4 DTM, which optimises the air flow and, as a result, the brake cooling. Just like on Formula 1 cars, the brake discs are no longer fed with cooling air through pipes but are cooled by air channelled through carbon-fibre ducts mounted directly to the suspension. The red brake calipers on the R10 are reminiscent of those fitted to Audi RS models.

The daytime low-beam lights, consisting of a row of white light-emitting diodes, which appear to have a light blue glimmer, also originate from production. The R10 rear lights consist of very bright LED's.

## **Development**

### **Intensive test programme before Le Mans 2006**

The idea to develop a diesel sportscar for the 24 Hours of Le Mans had already emerged in 2002 with the internal project name "R10" which ultimately became the new Le Mans sportscar's official type designation – just like its successful predecessor the R8. Things became very serious in September 2003 when the concept guidelines for the new Audi R10 were determined. "That was the most important stage," says Ulrich Baretzky, Head of Engine Technology at Audi Sport. "You have to define the number of cylinders, the engine's length, bore and stroke. Everything else results from these basic dimensions. If you make a mistake at this stage, it is almost impossible to correct later. That's why we considered every facet very carefully before we fixed the package."

In Spring 2004, the decision was made to select a twelve-cylinder engine with the maximum permissible cubic capacity of 5.5 litres allowed for Le Mans, which also affected the chassis. "Compared with the R8, the engine's length has grown through the number of cylinders, and because of a diesel's typical power and

strength,” explains Wolfgang Appel, Head of Vehicle Technology at Audi Sport. “In this respect we had to react by making everything as light as possible on the chassis side.” The R10 has a significantly longer wheelbase as a direct result of the large capacity engine.

The Le Mans V12 TDI ran for the first time on the test bed in July 2005. “It was incredibly interesting, because we really have explored completely new territory with this engine,” says Ulrich Baretzky. “Previously, together with our colleagues from the production car development, we had made basic tests with modified production engines and a single-cylinder model. That was all!”

The new power unit had already clocked-up approximately 1000 test-bench hours, including several endurance runs, before the R10 prototype’s roll-out on 29 November 2005. The V12 TDI will have almost 3000 test-bench hours to its credit and several thousand test kilometres in the back of the R10 before Le Mans.

During the test stage, Audi Sport follows the same paths that proved themselves with the R8: The dynamometer tests follow an extensive test programme carried out at various circuits and a test race, the 12-hour race in Sebring, on 18 March 2006. “The circuit's characteristics make this race one of the hardest in the world and the perfect opportunity to put a new car through its paces,” explains Wolfgang Appel. “More endurance runs are planned afterwards so we should be well prepared for the race at Le Mans in spite of time being short.”

The new Audi R10 will run for the first time around the 13.650 kilometre “Circuit des 24 Heures” at the official test day on 4 June 2006 which, less than two weeks before the race, represents the only test opportunity at the high-speed circuit formed partly by normal public roads.

“It is one of the peculiarities of this race that you can only test on a single day each year at Le Mans,” says Head of Audi Motorsport Dr Wolfgang Ullrich. “Le Mans offers the unique combination of speed, reliability and team work – and, if you chose to describe things more extremely, the running of an entire Formula 1 season over the course of a single weekend with one and the same car.”

In spite of the intensive preparation programme, lying between the R10 presentation on 13 December 2005 in Paris and the race on 17/18 June 2006 during which every day is planned, Dr Ullrich remains cautious in his predictions:

“Obviously, it is our target to have a car that is capable of winning and with which we can stand on the top step of the podium in 2006 if everything falls into place and we have a little luck. You can't guarantee victory in motorsport, least of all at Le Mans.”

## **Technology transfer from Motorsport to Production**

### **Motorsport accelerates development of TDI**

The LM P1 category is not only the “top class” at the 24 Hours of Le Mans – it is currently the most technically interesting category in motorsport. No other class offers an automobile manufacturer so many possibilities to implement new technology and to test these for production, particularly in the engine sector.

Additionally, the organising Automobile Club de l'Ouest (ACO) place increasing value on environmental compatibility. The ACO's target is to promote the development of environmentally friendly, quieter and more economical high-performance engines from which production cars can also benefit in the future. Therefore, the regulations stipulate that engine speeds must lie in a similar rev range than production cars. A direct technology transfer from motorsport to production is therefore possible – unlike the extremely high-revving Formula 1 engine.

This is a decisive reason why Audi continues its involvement with Sports-Prototype racing. Audi successfully positions itself as the premium segment's most sporting manufacturer, whereby the motorsport involvement plays a far greater role than just a marketing instrument: For more than 25 years, the motorsport success of AUDI AG has been based on ground-breaking developments, which established themselves later in production.

The best examples of this are quattro drive, which recently celebrated its 25<sup>th</sup> anniversary, and TFSI technology which was used for the first time in the 2001 24 Hours of Le Mans and remains unbeaten in the French endurance classic since then. The Audi R8, the most successful Le Mans Prototype ever with 61 victories from 77 races, is still the only racing car in the world to combine turbo-charging and direct fuel injection.

In the meantime, TFSI is just as likely to be found in Audi's sporting production models as quattro drive, with which Audi initially revolutionised rallying in the 1980s before the concept went on to establish itself in circuit racing.

Audi takes a slightly different path with the Le Mans TDI project. Every second Audi sold today is delivered with a TDI engine. As inventor of the revolutionary Direct Diesel Injection for road cars, Audi has extensive technical know-how at its finger tips, which Audi Sport engineers could resource during the development of their first diesel race engine.

Through its diesel involvement in motorsport, Audi wants to increase its advantage in the TDI sector even further and accelerate the development of TDI technology. "With regard to fuel consumption, environmental friendliness, the combustion process and other new technologies we expect an enormous push in the coming years," says Ulrich Baretzky, Head of Engine Technology at Audi Sport. "We are still relatively close to the findings of our colleagues from production since we are breaking completely new ground in motorsport. However, this will change. I believe to be able to share the things that we developed specifically for motorsport with production in the future."

The start has already been made: The V12 TDI for Le Mans is the first Audi diesel engine with an aluminium cylinder block – technology which could also be interesting for production.

The permanent technology transfer between motorsport and production at Audi guarantees the close cooperation between Audi Sport and the Technical Development (TE) of AUDI AG. "Both parties benefit from this", confirms Head of Audi Motorsport Dr Wolfgang Ullrich. "Motorsport has often cleared the way at Audi for new technologies. At the same time, Audi Sport benefits from the enormous know-how held by production development. The Le Mans diesel project is the best evidence for this."

## **Audi at Le Mans**

### **Seven starts, five victories**

For Head of Audi Motorsport, Dr Wolfgang Ullrich, the 24 Hours of Le Mans is “the greatest motorsport challenge and one of only three races around the world also known by people who have little or no interest at all in motorsport.”

232,130 spectators lined the circuit to watch the race in 2005. 1,854 journalists were accredited. According to a study made by the Institute TNS, the global media resonance even exceeded that of the Formula 1 United States Grand Prix held on the same weekend.

Audi has been competing at Le Mans since 1999 – hardly any other automobile manufacturer has been so successful in probably the world's toughest car race. Five overall victories from seven starts are more than impressive results. Audi drivers mounted the winners' rostrum at the end of all seven races.

Audi made its presence felt in the long-distance classic from the very beginning. In 1999, Audi Sport Team Joest claimed a podium position on its Le Mans debut. In sweltering temperatures a year later, Audi, together with the Joest team, added its name to the long-distance classic's winners' list with a dream result: The three R8 prototypes that started occupied the first three positions.

During the 2001 season, the Audi squad proved that its victory the previous year was no coincidence: In treacherous conditions with occasional outbursts of torrential rain Audi celebrated a dominant one-two finish. The TFSI technology, used for the first time, played a decisive role. Thanks to fuel-direct-injection, the improved initial throttle response was a huge advantage for the Audi drivers on the rain-soaked track.

In 2002, the lower fuel-consumption arising from TFSI technology developed by Audi played a starring role in the one-two-three finish. The powerful 610 hp Audi R8 prototypes were not only the fastest cars in the field, but they also saved valuable time thanks to the TFSI engines because they had to stop to refuel in the pits less often.

With its hat-trick of wins, AUDI AG not only added another chapter to its motorsport history, but also to the Le Mans history books. Audi is the first manufacturer to be able to call a Le Mans trophy its own. At the beginning of the 1990s, the Automobile Club de l'Ouest (ACO), organisers of the 24 Hours of Le Mans, created the trophy that is awarded annually to the Le Mans winner and is returned to the ACO before the start of the next race. At the same time, the organiser decided that a manufacturer winning the 24 Hours of Le Mans three times in succession with the same team could keep the trophy.

Audi Sport Team Joest achieved this "hat-trick" in 2000, 2001 and 2002. In September 2002, Prof. Dr. Martin Winterkorn, Chairman of the Board of Management of AUDI AG, accepted the trophy from former ACO President Michel Cosson. Since then it has been on display at the Audi Museum Mobile in Ingolstadt. In return, an example of the most successful Le Mans Prototype ever can be seen today in the automobile museum in Le Mans.

The link between Audi and the world's most important long-distance race goes even further: At the IAA in 2003, Audi unveiled the Le Mans quattro – a sportscar study, which will go on sale as a production car at the start of 2007 and carries the name that wrote motorsport history: Audi R8.

Audi importer teams clinched two further victories at Le Mans since 2003 but Audi now returns to Le Mans as a "works" team with the new R10. The development team from Audi Sport is supported by Reinhold Joest's squad which also performed this task during the R8 project and has won Le Mans already seven times.

An entry of two R10 prototypes is planned. In addition, the new R10 could be entered in all racing series' with their roots in Le Mans. "We consider programmes in the ALMS, the LMS in Europe and possibly also in Asia," says Head of Audi Motorsport Dr Wolfgang Ullrich. "Nothing has been confirmed as yet."

## **Audi and TDI Technology**

### **The first diesel race engine from the inventor of TDI**

That Audi is the world's first automobile manufacturer to compete for overall victory at the legendary 24 Hours of Le Mans with a diesel engine and is, as a result, a step ahead of the competition is almost self-explanatory: Audi is the inventor of the TDI and therefore the trend setter in this area.

At the International Car Show in Frankfurt in 1989, Audi presented the world's first diesel engine with direct injection and complete electronic engine management for use in passenger cars – a five-cylinder TDI producing 120 hp and 265 Newton metres torque. It was the birth of the revolutionary TDI technology which helped the diesel to change its image: Slow, loud and uncultivated were superseded by agile, comfortable and extremely economical. The Audi TDI brought the opposites of sporting-dynamic and long-range through low consumption in an emotional way down to a common denominator, without neglecting the diesel's exceptional reputation: its long-life.

Today every second Audi is delivered with a TDI engine – the outlook is bright. Audi has constantly set new technical standards during the development of the TDI engines over the last 16-years. The current highlight is the Audi V8 4.2 TDI quattro with 326 hp and 650 Newton metres torque – one of the most powerful compression ignition engines found in a production limousine – and all this whilst complying with the EU 4 emission limits and with an average fuel consumption of 9.4 litres per 100 kilometres.

With the V12 TDI for Le Mans, Audi demonstrates impressively just how much potential TDI technology has. The Audi customers will once again benefit from the experience gained in motorsport as they did from the R8 and the quattro models.

## **Audi Sport and Audi Motorsport History**

### **Winning series**

To implement such an ambitious project like the world's first diesel powered sports car which can fight for overall victory at the 24 Hours of Le Mans, a high-calibre team is required. Audi Sport, located for more than 25 years in Ingolstadt

and Neckarsulm, is a guarantee that Audi races from victory to victory and that the Audi brand also demonstrates “Vorsprung durch Technik” in motorsport.

The Audi R10, developed in conjunction with trusted and proven partners, was also completely developed by Audi Sport. Head of Audi Motorsport and Audi Sport since November 1993 is Dr Wolfgang Ullrich. His squad of around 150 employees are principally responsible for the development and testing of the racing cars. In charge of the R10 were – as was the case with the successful R8 – Wolfgang Appel on the chassis side, Ulrich Baretzky for the TDI engine and Rainer Kammergruber as Sportscar Project Leader.

Every project previously undertaken by Audi Sport was rewarded with a victory or championship titles. The success story began in 1981 with the Audi quattro. The dominating victories of the “original-quattro” in the World Rally Championship at the start of the 1980s were an important factor in the successful marketing of quattro drive and demonstrated impressively that the company slogan “Vorsprung durch Technik” should be taken literally. The quattro celebrated its first victory in only its second World Championship. It helped Michèle Mouton become the first woman to win a round of the World Rally Championship and Audi to a total of four World Championship titles.

After Audi had turned the rallying world upside down and stormed up the famous mountain ‘Pikes Peak’ in the USA in record time on three successive occasions, Audi made quattro drive trendy in circuit racing. Initially in 1988 and 1989 with the Audi 200 quattro TransAm and the Audi 90 quattro IMSA-GTO in the USA, in 1990 and 1991 with two championship titles for the Audi V8 quattro in German Touring Car Championship (DTM), and finally with A4 in the production based Super Touring Cars. In 1996, Audi won the national championships in seven countries.

After the all-conquering quattro drive was banned from touring car racing at the end of the 1997 season Audi changed to sport-prototypes and went on to demonstrate its technological prowess in this motorsport category as well. In 2005 the Audi R8 celebrated its fifth triumph in Le Mans. The R8 has won a total of 61 races from 77 – a unique balance.

The “works” comeback in the DTM also came up trumps: Audi won all three titles in the 2004 season with the newly developed A4 DTM.

Just as Audi Sport broke new ground with quattro drive and the TFSI engine, it once again opens up completely new territory with the Audi R10. “The R10 project is the greatest challenge ever to have been placed in Audi Sport’s hands,” says Head of Audi Motorsport Dr Wolfgang Ullrich. “TDI technology has not been pushed to its limits in motorsport yet. We are the first to confront the challenge; the demands of such a project are accordingly high. Long-term technology partners such as Bosch, Michelin and Shell support us in our quest. Together we have the chance to write new chapters in the history books of motorsport and diesel technology.”

### **Technical partners – R10 project**

## **Bosch, Michelin, Shell & Co**

The success of AUDI AG in motorsport is no coincidence. The company’s technical expertise is a guarantee for this – however, cooperation with the best external technical partners is also important.

Most of the partners involved in the R10 project have already been working successfully with Audi Sport for many years – and with several since the start of the “original quattro” project at the beginning of the 1980s.

Bosch, Michelin and Shell have all played particularly important roles. As was the case with the direct fuel injection TFSI, which was developed by Audi and Bosch together, Audi Sport and Bosch continue their cooperation for the R10 project. The V12 TDI engine management is performed by the Bosch Motronic MS14. The latest generation Common Rail System also originates from Bosch. The input is however not only limited to the engine: A completely new vehicle-data-logging system (FDE) was created together with Bosch.

Michelin was an exclusive and reliable tyre partner during the R8 years. The R10 project also makes new demands of the current Formula 1 World Champions: A wider front tyre was designed specifically for Audi. The enormous torque of more than 1,100 Newton metres produced by the TDI engine makes great demands on the rear tyres, which only one tyre partner with a technical background like Michelin could deal with.

Shell, another partner previously involved with the R8, is also on board. Shell V-Power Diesel is a particularly efficient fuel, from which the R10 will also benefit: From 2006 Shell V-Power is the official fuel supplier for the 24 Hours of Le Mans. Shell uses the R10 project to develop the next generation of Shell V-Power Diesel.

Numerous other proven technical partners have contributed to the R10 project: The gearbox was designed together with the company X-trac, the carbon fibre monocoque was created under the watchful eye of Audi Sport at Dallara. ZF Sachs supplied the clutch – a partner with whom Audi Sport have been working since the rally days. Megaline supplies the gearbox control system and the new high-tech steering wheel, O.Z. the wheels, Öhlins the dampers and Garrett the turbo chargers.

# Audi R10 technical data

Le Mans-Version 2006 - Status: December 2005

Model

**Audi R10**

<b>Vehicle</b>	
Vehicle type	Le Mans Prototype ("LM" P1)
Monocoque	Carbon-fibre composite construction with aluminium honeycomb core. Complies with the strict FIA crash and safety standards.
<b>Engine</b>	
Engine	90° V12 turbo-charged engine, 4 valves per cylinder, DOHC, 2 Garrett-turbo chargers, 2 x 39.9 mm engine-air intake restrictors (defined by regulations) and maximum turbo pressure of 2.94 bar absolute, diesel direct injection TDI, stressed aluminium crankshaft case
Engine management system	Bosch MS14
Lubrication system	Dry sump, Shell oil
Cubic capacity	5500 cc
Power	over 650 hp
Torque	over 1100 Nm
<b>Drive / transmission system</b>	
Drive	Rear wheel drive
Clutch	Ceramic clutch
Gearbox	Pneumatically-actuated sequential race gearbox, partner X-trac
Differential	Viscous-mechanical locking differential
Drive shafts	Constant velocity tripod plunge-joint driveshafts
<b>Suspension / steering / brakes</b>	
Steering	Electronically controlled power steering (rack and pinion)
Suspension	Independent front and rear double-wishbone suspension, pushrod-system with torsion bar and adjustable dampers
Brakes	Dual-circuit hydraulic braking system, mono-block light-alloy brake calipers, front and rear ventilated carbon fibre brake discs, driver adjustable infinitely variable brake-balance
Wheels	O.Z. magnesium forged wheels, front: 13x 18 inch, rear: 14.5 x 18 inch
Tyres	Michelin radial, front: 33/68-18, rear: 37/71-18
<b>Weight / dimensions</b>	
Length	4650 mm
Width	2000 mm
Height	1030 mm
Minimum weight	925 kg
Fuel tank capacity	90 litres