



PORSCHE

40 Years Class C

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Group C and IMSA GTP

The main areas of application of the Porsche 956/962 IMSA/962 C

For the 1982 season, FISA (Fédération Internationale du Sport Automobile) changed the regulations significantly for sports and touring cars. The former groups 1 to 6 were to be reduced to three groups: A (mass-produced touring cars), B (small-series GT vehicles) and C (prototype sports cars). The new regulations for Group C were submitted in draft form in July 1980, with the first official version being published in October 1981. Group C was defined as a pure prototype class. There were therefore no homologation requirements either for the minimum number of vehicles built or the use of series components.

Cars built according to Group C regulations would go on to compete in World Sportscar Championship races held between 1982 and 1992. Group C cars were also to compete in the German Racing Championship (DRM) between 1982 and 1985. This event was set to be held in 1983 and 1984 as the International German Racing Championship and in 1985 as the International German Sportscar Championship. Group C cars were also to compete in the Supercup from 1986 to 1989.

The racing career of Group C cars lasted longest in the North American IMSA GTP series, with vehicles in this class eligible from 1981 to 1993. The 962 IMSA was only entered for the first time in 1984.

The North American IMSA GTP series includes both endurance races, such as the 24 Hours of Daytona and the 12 Hours of Sebring, and sprint races on city circuits as well as 200-mile races on permanent racetracks. Group C racing cars were also able eligible for the Interseries.

Fuel consumption formula as a central focus of Group C regulations

From a marketing perspective, vehicle manufacturers saw Group C as a highly attractive proposition, given that most significant sales markets were covered: Europe and Asia had the World Sportscar Championships, while North America had the IMSA GTP series), and the 24 Hours of Le Mans was a race of global renown. As a result, several manufacturers

were already getting involved in Group C with factory outfits in the early stages of the formula.

With Group C, FISA replaced both the closed-cockpit production-based racing cars of Group 5 and the open-roofed sports car prototypes of Group 6. Whereas the former classes were organised according to displacement, Group C took a new direction, with a fuel consumption formula dictating the class. FISA set out a minimum vehicle weight of 800 kg (850 kg from 1984) and a maximum tank capacity of 100 litres. The displacement was exempted, as was the use of forced induction, for example a turbocharger or supercharger. Five refuelling stops were allowed during a 1,000-km race, which was the minimum distance in the World Sportscar Championship at the time; this equates to a restriction on fuel consumption to 60 litres per 100 km. This restriction did not, however, apply to the IMSA GTP series, whose races were held outside FISA's jurisdiction and run according to its own separate regulations. There were no restrictions on fuel consumption for the IMSA series and the fuel tank capacity of an IMSA GTP vehicle was 120 litres. The maximum engine displacement was 2.8 litres. Vehicles also had to be driven by series-produced engines until 1989; this meant that for the IMSA GTP series Porsche had to opt for a fully air-cooled engine based on the 911 (930) Turbo with a single turbocharger.

Since the idea was for as many different manufacturers as possible to get involved in Group C, not just a few financially strong works teams, FISA introduced Group C Junior as far back as 1982, renaming it Group C2 in 1985. The junior category was modelled on the former Group C cars (now known as Group C1), so FISA made use of a fuel consumption formula here too. Racing cars in Group C Junior or Group C2 had a minimum weight of 700 kg and a maximum tank capacity of 55 litres. With five refuelling stops allowed during a 1,000-km race, this worked out at a consumption of 33 litres per 100 km. While Group C1 was dominated by turbocharged racing cars, Group C2 was made up predominantly of cars using naturally aspirated engines.

FISA reduced the amount of fuel permitted by 15 per cent for the 1985 season. This meant a reduction to just 510 litres in a 1,000-km race compared with the previous 600 litres. FISA also adopted some of the regulations used in the US IMSA GTP, such as the roll-over bar (now to be made from steel), and the accelerator, brake and clutch pedals being located

behind the front axle. The generational change from the previously dominant 956 to the 962 for IMSA and the 962 C was therefore also evident at Porsche.

Shorter racing distances and engines in line with the Formula One model

The nature of the regulations ensured strong and diverse manufacturer involvement, and the public enjoyed watching exciting races. Yet despite the ever-increasing popularity of Group C in the media and among the public, FISA changed the regulations for the 1989 season. The minimum distance for races in the World Sportscar Championship was initially reduced from 1,000 to 480 km, with a further reduction to 430 being made in 1991. At the same time, FISA abandoned its fuel consumption formula for the category in 1989. In its place, following the example of Formula One, where turbocharged engines had been banned since 1989, vehicles had to be powered by 3.5-litre naturally aspirated engines. Turbocharged engines with limits placed on fuel consumption were still permitted until the end of 1990. The 1990 regulations therefore included provisions for naturally aspirated engines (category 1) and for turbocharged engines (category 2).

This package of changes meant that the formerly prosperous Group C was seen as increasingly unattractive; the result was that FISA cancelled the 1993 season of the World Sportscar Championship due to a lack of entries. However, GT cars saw a renaissance and starting grids were growing. A final sanctuary for Group C was the 1993 24 Hours of Le Mans. Not many of the Group C vehicles, however, complied with the new regulations concerning 3.5-litre engines. The majority were Group C1 and C2 vehicles, which complied with the old regs.

IMSA GTP races appealing to the public

With the entry of further manufacturers, the IMSA GTP series became a major attraction in the second half of the 1980s and attracted numerous top drivers thanks to its high prize money. The racing series was also hugely popular among viewers, since the starting fields were sometimes twice the size of those in Group C. The series faced a crisis in the 1990s for many reasons. Porsche and other manufacturers withdrew in 1992, and since the Porsche 962 was no longer competitive, more and more private teams also left the series. The following year, audiences and sponsors also ultimately turned away from the racing

series, which by then had lost its appeal, and the final race took place in Phoenix on 2 October 1993.

The Porsche 962 C outlives Group C

Although Group C was consigned to the history books in 1994, some Group C vehicles celebrated a remarkable renaissance. In 1994, Jochen Dauer's team achieved an overall victory at Le Mans with a Dauer 962 Dauer Le Mans GT. This was a Porsche 962 C, which was approved by Dauer for road use and was built for Le Mans according to the regulations of the new GT1 class and therefore competed not as a prototype but as a road-going sports car. Counterparts to the Dauer 962 Dauer Le Mans GT are the Schuppan 962 CR, which was also road-legal, and the Koenig-Specials C62.

The Porsche 962 C surfaced again in 1996 and 1997. In both these years, Reinhold Joest's team took first place with a vehicle known as TWR Porsche WSC-95. This was an open-cockpit racing car, which combined a Jaguar XJR-14 chassis with a Porsche 962 C engine. The Cologne-based Kremer team also developed three vehicles based on the Porsche 962, which entered races between 1994 and 1998 under the name Kremer K8 Spyder.

Racing successes

Le Mans and World Sportscar Championship

The Porsche 956 proved its capability in Group C in its very first season back in 1982. Porsche scored a superb one-two-three finish at the 24 Hours of Le Mans. The previous year's winners, Jacky Ickx and Derek Bell, triumphed with the new Group C racing car after 359 laps. Second and third place went to the two other 956s, driven by Jochen Mass and Vern Schuppan, as well as Hurley Haywood, Al Holbert and Jürgen Barth. The three 956s crossed the finish line in the exact order they started – 1, 2 and 3. At the end of the 1982 season, the 956 finally won the World Sportscar Championship. The following year, it won again at Le Mans and also defended the title of World Sportscar Champion with Jacky Ickx.

History was made on 28 May 1983, when Porsche works driver Stefan Bellof went round the Nürburgring Nordschleife circuit during practice in a time of 6:11.13 minutes, with an average speed of more than 202.053 km/h. This record was unbroken for 35 years and 31 days, until the morning of Friday, 29 June 2018.

On that day, Porsche works driver Timo Bernhard went round the 20.832-km Nordschleife of the Nürburgring in the Porsche 919 Hybrid Evo in a time of 5:19.55 minutes. Bernhard therefore improved on the previous track record set by Stefan Bellof by 51.58 seconds. His average speed on the world's most difficult racetrack was 233.8 km/h.

The Porsche 956 was also victorious at Le Mans in 1984 and 1985 and, from its debut until 1984, also dominated the World Sportscar Championship, which included the Manufacturers' Championship in the form of the World Endurance Championship as well as the Drivers' World Championship. In 1984, Joest Racing won with Klaus Ludwig and Henri Pescarolo, and while the factory had already brought in the 962 C in 1985, the prestigious overall victory at Le Mans still went to the Joest Porsche 956 with Klaus Ludwig, Paolo Barilla and John Winter.

The year 1984 saw the introduction of the Porsche 962 C and 962 IMSA, which were both further developments of the 956. Unlike the 962 C or the 956, the 962 IMSA had to comply with the regulations of the American IMSA GTP series, since the 956 did not meet the American rules, in two respects in particular. Porsche had to extend the wheelbase by

12 centimetres, as the IMSA GTP regulations required the pedals to be located behind the front axle for safety reasons. A further requirement was that the aluminium monocoque had to be fitted with a roll cage made of steel instead of aluminium. To keep costs down, the 956's four-valve-per-cylinder biturbo engine had to be replaced by an air-cooled two-valve-per-cylinder, single-turbo engine for use in IMSA GTP. The different exhaust systems of the 962 IMSA and 962 C could be seen clearly from the outside. In the IMSA-962, the exhaust pipe passed through the diffuser at the rear. On the 962 C, the exhaust tailpipes were mounted on the side.

The 962 C was built to compete in the World Sportscar Championship and in particular at Le Mans. Initially fitted with a 2.65-litre four-valve-per-cylinder biturbo engine, the 962 C was powered by the then fully water-cooled 3.0-litre four-valve-per-cylinder biturbo engine with up to 515 kW (700 PS) of power achieved for the first time during practice at Le Mans in 1985. Up until then, only the cylinder heads of the 956 had been water cooled, with the cylinders having been air-cooled.

The 956 was unbeaten at Le Mans from 1982 to 1985, and this success was seamlessly continued by its successor, the 962 C, which took first place in the 24-hour race at the Circuit de la Sarthe in 1986 and 1987. In total, Porsche won five Drivers' Championships and three World Endurance Championships with the 956 and 962 C between 1982 and 1986.

Supercup

The Supercup racing series, which ran from 1986 to 1989, was heralded as the successor to the German Racing Championship (DRM) for Group C sports car prototypes. In its first season in 1986, the championship – named after its sponsor, the car magazine 'sport auto' – was held as the ADAC sport auto Supercup. Following a change in sponsor, in 1987 and 1988 the race series was known as the ADAC Würth Supercup. Finally, in 1989, the Supercup was named the ADAC SAT1 Supercup after the TV station Sat.1, which broadcast the races live.

Porsche, with the 962 C, was involved right from the start. In 1986 and 1987, the Supercup races covered a distance of 180 km, with this distance rising to 220 km from 1988 onwards. From 1986 to 1988, the races were held exclusively in Germany. The season opener and finale were held at the Nürburgring, and in 1986 there were also races at Hockenheim and

the Norisring. Originally, the AVUS in Berlin was also on the racing calendar, but for safety reasons the high-speed circuit was cancelled, only later being replaced by Diepholz from 1987 onwards. In 1989, the final Supercup year, Silverstone in England replaced Hockenheim.

From the start, the 962 C dominated the track and Hans-Joachim Stuck won the Drivers' Championship title in 1986 and 1987. In 1987, Porsche once again entered the 962 C in the Supercup. As well as racing victories and title wins, the focus for that year was also on technical innovation: most notably in 1986, Porsche started testing the ground-breaking Porsche dual-clutch gearbox (PDK) in the 962 C. The PDK enabled very fast, smooth gear changes at full throttle with virtually no interruption to the engine's power delivery – and is now available in many Porsche production models.

In four out of five races in the 1987 season, Hans-Joachim Stuck was in pole position with the 515 kW (700 PS) car; he set the fastest lap at all the events and, with two wins, two second places and a third place, took the championship title ahead of his brand team-mate Bob Wollek, who drove a 962 C for Joest Racing. The team ranking was also clearly in the hands of Porsche. The Porsche works team won ahead of Joest Racing.

IMSA GTP

Porsche racing cars had been competing in IMSA GTP right from the outset, and in 1982 the American John Paul Junior drove to victory in the Porsche 935. In 1985, his fellow countryman Al Holbert ultimately demonstrated the power of the Porsche 962 by winning the championship. He went on to repeat this success in 1986. The American Chip Robinson finally completed the hat trick with the 962 in IMSA GTP in 1987.

All Japan Sports Prototype Championship

The Porsche 956, 962 IMSA and 962 C also impressed in the All Japan Sports Prototype Championship. When the 1983 racing series, known as the Zen-Nihon Taikyū Senshūken (All Japan Endurance Championship), began, racing cars from Group C of the World Sportscar Championship and the IMSA GTP formed the core and also drew in the crowds. Following the exclusion in 1987 of the touring cars that also competed, the series was renamed Zen-Nihon Sports Prototype Car Taikyū Senshūken (All Japan Sports Prototype Car Endurance Championship). The racing series ran for nine years and delighted fans and

participants alike thanks to the competition between the Porsche 956, 962 IMSA and 962 C, which were usually driven by private teams, and Japanese car manufacturers, who entered with their own works teams. The decline of Group C and the IMSA GTP was followed by the cancellation of the popular racing series in 1992.

In the very first year, 1983, Naohiro Fujita and Vern Schuppan won the championship with the 956. Two further titles followed in 1985 and 1986 for the driver pairing of Kunimitsu

Takahashi and Kenji Takahashi, once again with a Porsche. Driving with Kenny Acheson, Kunimitsu Takahashi gained his personal hat trick in 1987, becoming champion for the third time in a row. In 1988, Stanley Dickens and Hideki Okada wrapped up Porsche's fifth title win. Dickens repeated this success the following year alongside driving partner Kunimitsu Takahashi.

Bodywork and chassis

The newly established main motorsports department moves to Flacht

Work on the 956 project began back in July 1981, one month after the overall victory of the 936/81 at Le Mans. The official green light was given on 1 August 1981, the start of the new financial year.

Peter Falk became head of the newly established main motorsports department, acting as the head of race development and racing director. Norbert Singer took on responsibility for the 956 project.

Peter Falk: "This car was Norbert Singer's baby. Much preferring the practical approach, he wasn't one to stand at the front lecturing. He was one of the first in our office to own a computer, spending a great deal of time working on it right from the start. Singer headed up the project and designed the aerodynamics. It was quite a revolution to harness the ground effect from Formula One for a prototype."

Norbert Singer on working with Peter Falk: "He also gave me a great deal of free rein in the development of the 956, made important decisions concerning the technology within the team and then took full responsibility for them. That is not an everyday occurrence in today's world."

The establishment of the new main department marked the organisational separation of the motorsport department from the press department, which had headed up motorsport operations until that point. This reorganisation also had geographical consequences. The entire motorsports department was given its own premises, about a kilometre away from the actual Weissach development centre and on the boundary with the district of Flacht. Peter Falk and his main department moved to less luxurious barracks and the former tank hall, which housed the motorsports workshops and the model workshop.

Walter Näher joined from the series development department, and Klaus Bischof moved to the newly formed team from the motorsport workshop. Horst Reitter was responsible for the monocoque chassis, with Eugen Kolb designing the bodywork and Norbert Singer taking

over wind tunnel development. Manfred Wanner was responsible for building the 1:5 scale wind tunnel model. When the company procured its own wind tunnel in 1986, Norbert Singer and his colleagues Dr Reiner Müller, Rolf Junginger and Heiko Mikula pushed ahead with aerodynamic development. Valentin Schäffer, who had already been responsible for the previous turbo engines such as the 917/10, 917/30, 934, 935 and 936, was in charge of developing the turbo engine.

Aeronautical engineering used to construct the monocoque

In building the chassis, Norbert Singer's team broke new ground. Instead of using a traditional tubular frame, a technique that had been established for decades, the 956 had a monocoque made of one-millimetre-thick aluminium sheeting. Helmuth Bott, Board Member for Development, initially favoured a tubular frame design for the 956 too, but the greater safety provided for the driver ultimately convinced him to opt for the more modern option.

The construction of a monocoque made of carbon laminate instead of aluminium, which was already being used in Formula One at the time, was also considered. However, Porsche did not have its own autoclave at the time, so Norbert Singer and Klaus Ziegler, foremen in the Composite Materials department, obtained a quote for buying in a carbon monocoque. "It came to over a million marks, which was a lot of money," Singer recalls. In the end, the quote was declined. The proposal from Klaus Ziegler's department to construct a synthetic monocoque in-house was also rejected for reasons of production capacity and budget, so a monocoque made of aluminium turned out to be a viable solution.

However, producing a monocoque from aluminium sheets also represented new territory for Porsche. "At the time, we had no experience whatsoever, so we approached Dornier in Friedrichshafen. They grinned a bit at first, but were then very helpful in telling us which rivets, rivet spacings, adhesive and tooling we needed to make a monocoque. Then we headed back and set about creating the first test specimens using this process. After that, we subjected the manufactured aluminium bodies to torsion to see what would happen," recalls Norbert Singer, describing how the know-how for monocoque production was built up under high pressure. Finally, rigidity tests followed on the first experimental chassis, which achieved 80 per cent higher rigidity than the 936's tubular spaceframe. "The second chassis we built was number 956 001, which was our first race car," Singer continues.

The joining together of the individual pieces of sheet metal finally resulted in the monocoque. In terms of its dimensions, it extended roughly from the front axle to above the driver's seat and, along with a welded-on roll cage made of circular aluminium tubing, formed a safety cell for the driver. The roll cage was also used to strengthen the substructure. The engine was bolted on directly behind the rear wall of the monocoque. Between the engine and the gearbox was the 'ox horn'. This was a magnesium component that held two steel tubes on each of the two booms, one on the left and one on the right, which ran diagonally upwards to the rear wall to further secure the drivetrain. Directly behind the 'ox horn' was the gearbox, which also acted as a chassis support for the two tubular steel suspension bell cranks, which in turn linked to the magnesium wheel carriers. The bell cranks also linked to the compression-loaded suspension struts that were bolted to the gearbox at an angle. A double wishbone design was used on the front axle. The lower wishbone was made of tubular steel, while the upper wishbone was composed of an elaborately milled rear aluminium strut and a front adjustable aluminium round strut.

Complex rivet bonding technology – the 'Porcupine'

The construction of the monocoque involved high-quality and elaborate craftsmanship. For example, the individual sheet metal parts were joined using a rivet-bonding technique, following principles used in the construction of metal aircraft. A tape soaked in epoxy resin is used for bonding, and the two sheets are then riveted together. The riveting, which must be carried out immediately after application of the adhesive tape, is performed by two people using a riveting hammer assisted by compressed air. This requires a second person to position the heavy counterweight for the riveting hammer.

Before the individual sheet metal parts are joined, however, the construction of the monocoque requires a great many preparatory steps. These range from absolutely precise cutting to size, as per the relevant design drawing, to the pressing of various openings, for example for hose guides or in the front side panel, to the exact drilling of the holes for the subsequent riveted joints. Not only do the openings pressed at certain points give the monocoque a handcrafted and pleasing appearance, but the way they are shaped – by flanging – also increases the rigidity of the component while reducing its weight. This design principle can still be found in many areas of aircraft construction today – for example in fuselage frames or wing ribs. The monocoque was therefore created sheet by sheet, and at

this stage was still held together by screw staplers or tacking needles in place of the rivets that would later be used. Once complete, this resulted in a structure that, in line with Porsche's tradition, was given a nickname in Norbert Singer's team due to the countless screw staplers: The Porcupine.

Body made of glass fibre reinforced plastic (GRP)

The body of the 956 was built under the direction of Eugen Kolb using the well-known, tried-and-tested construction method of glass fibre reinforced plastic (GRP). First of all, this requires the construction of a 1:1 model of the body from rigid foam. Finally, negative moulds are made from this 1:1 model in GRP, which can then be used to manufacture the bodywork parts.

The body consisted of a removable front and rear section as well as a centre section that accommodated the two doors. These opened upward and were hinged from the leading edge of the door so that they opened towards the windscreen, too. This central body section was not designed to be removable, but was bonded to the aluminium monocoque, making the car more rigid overall.

The lightweight construction principle could be seen at various points on the body, for example on the front end, with laminated aramid honeycombs (Kevlar). These Kevlar elements were sandwiched between the outer and inner layers of the glass fibre laminate, forming a hollow body that gave the component enormous additional rigidity without increasing its weight. This method is also common in aircraft construction, for example in the production of gliders.

Both the short-tail and long-tail versions of the 956 measured 4,800 mm in length. According to the original technical regulations for Group C, the front and rear body overhangs were not permitted to measure more than 80 per cent of the wheelbase in total. At 2,650 mm, the 956 had the longest wheelbase of any Porsche racing car to date. FISA also stipulated that the difference between front and rear body overhang must not exceed 15 per cent. For this reason, the long-tail version of the 956 had a longer rear section, but with an attached rear wing, while the short-tail version had the rear wing protruding to the rear.

Aerodynamics

Ground effect and Singer-dent

We have seen, Under Norbert Singer's leadership, the emergence of the 956 – a car with remarkable aerodynamic properties. Two specific technical details had a significant influence on possible cornering speeds: the 'Singer dent' at the front of the underbody, named after Norbert Singer himself, and a long diffuser, which started ahead of the centre of the vehicle and extended all the way to the rear. As speeds increased, this created an ever-stronger vacuum, which quite literally sucked the 956 to the ground. This enabled very high cornering speeds and gave Porsche a decisive advantage during races.

Wind tunnel work took place at the University of Stuttgart's Research Institute for Automotive Engineering and Vehicle Engines (FKFS) and at Volkswagen

But getting there was a labour-intensive and time-consuming process. This is partly because Porsche did not have its own wind tunnel at the time. So work began using models in the 1:5-scale wind tunnel at the University of Stuttgart's Research Institute of Automotive Engineering and Vehicle Engines (FKFS) on the premises of Mercedes-Benz in Untertürkheim. This was where, at the end of the 1960s, even the legendary Porsche 917 had to prove itself when it came to aerodynamics.

At the time of the development of the 956, wind tunnel tests using full-scale models or finished vehicles were much more complex. These were carried out at Volkswagen in Wolfsburg, for example, and followed a strict timetable. "If we wanted to use Volkswagen's wind tunnel for a day, we had to have everything ready to go at seven in the morning," recalls Singer. "And the tests finished at 5:30 pm sharp. Then we had another half an hour to leave the building before it was locked at exactly 6 pm. It was very time-consuming to transport everything we needed to Wolfsburg,".

Ground effect

The declared objective of the aerodynamic development of the 956 was to create 'ground effect', which was already being applied to Formula One cars at this time. The basic idea behind ground effect is to create a vacuum between the vehicle floor and the road surface, which effectively sucks the car to the tarmac, thereby allowing higher cornering speeds.

“To begin with, we copied Formula One, with inverted wing profiles under the car and skirts that sealed this configuration to the sides. The ground effect in a Formula One car is mainly created by an airflow coming from the front. Our results were disappointing,” says Singer, explaining the particular problems associated with the aerodynamic development of the 956. “We were forced to admit that ground effect only built up properly under the comparatively wide monocoque of a sports prototype if air also flowed in from the sides and the underbody was designed accordingly.”

Eventually, a solution was devised that featured two or three diffusers, depending on the track. The short-tail version of the car, designed for high downforce on twisty circuits, had a diffuser ahead of the front axle in the form of an upward curvature of the underbody. This profiling accelerated the airflow, creating negative pressure and therefore downforce. This diffuser has gone down in the Porsche history books as the ‘Singer dent’.

In the area below the cockpit, the underbody was flat, in line with Group C technical regulations. To the left and right of this flat area were two diffusers in the form of elongated channels that extended to the rear of the vehicle. These two channels were designed so that air could flow in from not only the front of the vehicle, but also from the sides.

After completing this wind tunnel work for the short-tail version of the 956, Norbert Singer and his team turned their attention to the long-tail version. The aim was to reduce drag, thereby enabling a higher top speed. To achieve this, the profile of the two rear diffusers had a flatter shape for lower drag, but also lower downforce. To maintain the aerodynamic balance, the ‘Singer dent’ at the front of the front axle was closed.

As the values of the first 956 long-tail from 1982 show, when compared with those of the 936/81, 20 per cent more downforce was built up with identical aerodynamic drag; this highlights the effectiveness of ground effect in the long term. By way of comparison: the short-tail version of the 956, which was designed for twisty circuits with short straights, generated twice as much downforce as the long-tail version. In essence, the 956 short-tail would have been able to drive upside down on the ceiling above 180 km/h, while the 956 long-tail version could only have been driven upside down above 321.4 km/h.

Narrower tyres for even more downforce on the 962 C

When the 962 C was created as a result of the changes to the regulations for the 1985 season, Porsche took the opportunity to optimise its Group C racing car in aerodynamic terms as well. Since the flat wide six-cylinder boxer engine did not allow for an optimal design of the diffuser channels in the rear area, Norbert Singer was on the lookout for a new solution. “The wind tunnel had shown that we could improve downforce with narrower tyres and wider diffuser channels,” he explains.

With the support of tyre partner Dunlop, the 962 C therefore now had wheels that were only 14 inches wide instead of 16, but their diameter was increased from 18 to 19 inches. In terms of high cornering speeds, the tyre contact area was therefore roughly the same, but the reduction in tyre width meant that the diffuser channels can be made 50 mm wider, providing even more downforce.

Engines and gearboxes

Powertrain and PDK

The engine of the 956 was a six-cylinder boxer engine with water-cooled cylinder heads, air-cooled cylinders and four-valve technology. It was based on the Indycar engine developed for the Porsche Interscope project in 1979. Designed at the time for methanol, this 2.65-litre engine was derived from the unit in the 935/78, which had a displacement of 3.2 litres and produced more than 700 PS. In order to be used in Group C, the Type 936/81 engine was heavily revised to meet the Group C fuel consumption formula. The maximum engine speed was reduced and the boost pressure and compression was adjusted.

The Type 935/76 engine of the 956 had a 92.3 mm bore and 66 mm stroke, resulting in a displacement of 2649 cc. Boosted by two KKK Type K26 turbochargers with a maximum pressure of 1.2 bar, it delivered its maximum output of 620 PS at 8,200 rpm and the highest torque of 630 Nm was available at 5,400 rpm. In the years that followed the car's debut, this engine – which in essence was barely changed – was modified in terms of bore and stroke to produce further engine versions with displacements of 2994 cc (Type 935/79, 935/82, 935/83) and 3164 cc (Type 935/79, 935/86).

Racing engines based on the 911's 'Mezger' engine

As was the case for all six-cylinder boxer racing engines built up to that point, the engine designed by Hans Mezger for the first Porsche 911 in 1963 also formed the basis for the Type 935/76 engine. The crank case, which was divided vertically into two parts, was based on the 911 (930) Turbo's unit, but modified for racing use. For example, the crankcase was optimised in terms of flow towards the cylinder sides and had larger windows between the individual cylinder units to ensure more favourable pressure conditions and minimise undesirable pumping losses. As in the series-production engines of the 911, the cylinder stud bolts were made from Dilavar, a high-alloy steel.

Classic racing engine design was reflected in the six connecting rods, which were made from titanium and polished to a mirror finish. From the mid-1980s, the engine featured shot-peened titanium connecting rods for improved durability. The shot peening process was used simultaneously in series production in the TAG turbo engine in Formula One and

shortly afterwards in the 959 super sports car, the engine of which was closely related to those of the 956 and 962.

Pistons with circumferential cooling channels and electron-beam-welded blind cylinders

The cylinder barrel set was a technical highlight. It is worth noting that the pistons had circumferential cooling channels in the area of the ring grooves for improved cooling. The 'blind cylinders', in which the cylinder and cylinder head form a single unit, were a particular technical delight.

This unusual technical solution was developed in response to practical problems encountered in competition. This is because cars sometimes came in for pit stops and then burned out the cylinder-head gaskets on the way back onto the track. The reason for these defects was that the cylinder head fittings made of Dilavar cooled down more slowly than the aluminium cylinders and cylinder heads, which resulted in lower preload on the cylinder-head gasket. Porsche countered this by welding the water-cooled cylinder head and the 956's air-cooled (and later water-cooled) cylinders together using an electron beam process. This design, in turn, placed increased demands on the honing of the Nikasil-coated cylinders, as the honing tool had to manage without a runout towards the combustion chamber. However, this process was mastered without any issues at that time.

Twin overhead, gear-driven camshafts

In the Type 935/76 engine, the camshaft housing served as the overlapping component of the cylinder heads – this also applied to the very first 'Mezger' engine in the 911. The same applied to the intermediate shaft for the camshaft drive, with the two gears being placed at the front and rear to account for the cylinder offset of the boxer engine due to its design. However, the racing engine had two overhead camshafts in each case; these were also driven by a very precise gear drive rather than by chains. On the outlet side of the cylinder heads, the large water pipe guides to the cylinder heads directly at the outlet channels, which were subject to extremely high thermal loads, were striking. Worthy of note were the separate and therefore completely self-sufficient cooling circuits for the left and right engine sides, each with its own cooling water pump.

While all air-cooled series-production engines of the 911 have an overhead camshaft for each cylinder bank and associated valve actuation via rocker arms, the Group C racing engines of the 956/962 had direct valve actuation via tappets. The valve clearance itself was adjusted via overhead shims. This type of valve actuation was used for the first time in a 911-based Porsche series-produced vehicle with the 959 super sports car.

Careful assembly was vital with this type of engine. This applied in particular to the tooth flank clearance within the gear cascade for the camshaft drive. Too little clearance here would lead to bearing and tooth flank damage, while too much clearance would result in increased running noise and imprecise timing – and therefore in negative effects on performance and durability.

As was customary in racing engines, the combustion chambers were gauged. This gauging was used to control the combustion chamber volumes and therefore the compression ratios. For optimum performance and the best possible running behaviour, the values had to be identical on all cylinders. This measurement was also used to rule out compression ratios that may be too high and have a fatal effect on a turbo engine.

Numerous components, such as the wheel housings of the camshaft drive, the two magnesium oil scavenge pumps for the twin turbochargers and the cylinder head suction system, each driven by the exhaust camshafts, or the nine-blade fan impeller made of carbon fibre laminate, also bore witness to the consistent lightweight construction of the engine.

From mechanical to electronic fuel injection

The Type 935/76 engine featured mechanical fuel injection from Kugelfischer. “However, we used the Bosch Motronic MS2 for the first time as early as at the end of 1982 during test drives at Paul Ricard,” recalls Hans Eckert, who worked in the Porsche motorsport department from 1976, and was responsible for the body control system of the Group C cars. He was also chief mechanic for Stefan Bellof in 1983/84 and for Hans-Joachim Stuck in 1986/87. The Bosch Motronic MS2 was used for the first time in the engine now known as the Type 935/79 in September 1982 during free practice for the 1,000-km race at Spa-Francorchamps. The next use of the new fuel injection system dates from the 1,000-km race at Monza on 10 April 1983.

Porsche began working with the Bosch Motronic engine management system as early as 1979 as part of the Indycar project, and used a similar system that was almost ready for series production in the 924 GTP Le Mans in 1981. When Porsche applied the Motronic to the 956 with strong support from Bosch, Bosch developed a datalogging system with the aim of perfect engine tuning. This system could record values such as engine speed, boost pressure, throttle valve position and accelerator pedal position as a basis for programming the ignition and fuel injection maps.

Initially, the creation and modification of the maps was very time-consuming. It was based on a hexadecimal code that had to be created on a computer and then stored on a chip. This chip was then inserted into the Motronic control unit.

All the effort was worth it though. The Motronic not only improved fuel efficiency, which was particularly important in Group C, but also provided more power. In the years that followed, the Motronic 1.7 took a major leap forward with the development of knock control and the option of two different maps that could be activated by the driver.

Racing gearbox modelled on the 911 (930) Turbo

The gearbox with five forward gears and one reverse gear was based in part on the gearbox of the 911 (930) Turbo and was designed for a maximum torque of more than 800 Nm. Like the standard gearbox, it had helical gear pairs. Porsche went for lightweight construction in the form of a magnesium housing and rear axle drive shaft flanges machined from solid titanium.

The power transmission, which was equipped with a separate gearbox oil cooling system, was divided into three housing sections: the clutch housing, the 'ox horn', was a large magnesium component on the vehicle that also served as a carrier for the rear suspension. The rear axle drive with limited-slip differential was located in the middle section. It had a 100 per cent locking effect with rigid through-drive. On the 956, the differential housing was made of lightweight magnesium, while on the 962 C it was cast from aluminium for stability. Finally, the rear section housed the gearbox, with an input shaft at the top and the output shaft at the bottom.

As was the case with the engine, it was vital that the mechanics took the greatest possible care during gearbox assembly. After tightening the nuts of the input and output shafts, the shift forks in particular had to be adjusted very sensitively and precisely with the aid of an adjustment housing in order to ensure optimum shiftability during driving.

Short shift times thanks to Porsche's dual-clutch gearbox PDK

As early as the late 1960s, Porsche was working on the development of a dual-clutch gearbox with the aim of being able to perform gearshifts with virtually no interruption to the engine's power delivery. Since the control electronics that were fundamentally necessary for such a gearbox to function perfectly were not available at the time, this system still worked purely mechanically – as did the first PDK that Porsche developed for the 956. “That, however, proved to be a barely viable option. The system sometimes worked very erratically and gave drivers some unpleasant surprises,” recalls Singer. The decision was therefore quickly made to switch to an electronic-hydraulic control system.

The PDK worked with two clutches that alternately established the power connection with the engine via two separate drive shafts. However, during comparative test drives with the 956 at Paul Ricard in March 1984, Jochen Mass was still 2.3 seconds per lap slower with the PDK than with the manual transmission. Two years later, Hans-Joachim Stuck still lost 1.4 seconds with the PDK. As was evident in 1986 during the pre-tests for Le Mans, the PDK also lost out on top speed. Performance measurements on the test stand ultimately revealed that the PDK ate up around 20 PS in high rev regions. The PDK was also very labour-intensive. One contemporary witness remembers it well: “We had to fit and remove the gearbox every day.”

The moment finally arrived a year later, in 1987. In the meantime, the PDK had been reworked in the area of hydraulic control as well as electronics, and the power loss was now only 2.6 PS. Now Hans-Joachim Stuck was able to drive 0.7 seconds faster during tests at Paul Ricard than with the manual gearbox, and the 962 C equipped with PDK was now also ahead of its counterpart equipped with a conventional gearbox when it came to its top speed. The gearbox housing was now made of lightweight magnesium instead of aluminium. With Hans-Joachim Stuck winning the Supercup in 1986 and 1987, the PDK demonstrated its fighting power when it comes to racing.

Engines for the IMSA GTP

According to the regulations, only engines based on those of series production cars were able to be used in the American IMSA GTP series. For this reason, the 962 could not use water-cooled cylinders and cylinder heads for IMSA competition, as Porsche did not yet have a series production car with a corresponding engine in its range. Based on the engine of the 911 (930) Turbo, an air-cooled engine with a single turbocharger was therefore created, a unit that was closely related to the engine of the Porsche 934. This Type 962/70 engine had a displacement of 2,869 cc and was the power source of the Porsche 962 for IMSA GTP races in 1984. Boosted by a KKK Type K36 turbocharger, the engine produced 680 PS at 8,200 rpm, with a maximum torque of 660 Nm. Fuel injection was handled by the Bosch Motronic MS2.

While this engine proved efficient in racing applications, it was not sufficiently powerful for the future. However, since IMSA GTP regulations did not specify a fuel consumption limit as in Group C – and also permitted a fuel tank with a capacity of 120 instead of 100 litres – Porsche increased the engine's displacement to 3,164 cc. With 720 PS at 7,300 rpm and 830 Nm of torque, the Type 962/71 engine used between 1985 and 1987 proved to be significantly more powerful.

When IMSA limited the displacement for turbo engines in the GTP class to three litres in 1987 and also stipulated a restrictor, Porsche responded with the Type 962/72 engine, which had a displacement of 2,994 cc. Equipped with a KKK Type K32 turbocharger, the engine developed a maximum output of 695 PS at 8,200 rpm and a maximum torque of 710 Nm. As well as increased basic compression, the smaller turbocharger provided improved driveability and a more spontaneous response.

At the end of the 1980s, the 962 C and the 962 for IMSA GTP faced massive competition in the form of new cars from other manufacturers. However, since the 962 was then also allowed a water-cooled engine in IMSA GTP, the final development stage of the Group C engine emerged in the form of the Type 935/86 engine, which was used from 1989 to 1994. Equipped with the Bosch Motronic 1.7, the engine was fully water-cooled, had two overhead camshafts for each cylinder bank and a displacement of 3164 cc. Fed by two KKK Type K26 turbochargers, it delivered 740 PS at 8,200 rpm and 715 Nm of torque.