PORSCHE

Press Information

Porsche 918 Spyder at the Nürburgring

Contents

September 2012

Porsche 918 Spyder

Driving trials at the Nürburgring: Experiencing extreme performance at the “Green Hell”

The Porsche 918 Spyder is showing what is technically feasible today and is redefining performance limits. The 918 Spyder has reached a crucial phase in its development with tuning of its vehicle dynamics at the Nürburgring. Every Porsche turns laps on the legendary approximately 22 km long North Loop, covering thousands of kilometres in the toughest of sports car tests. One kilometre on what is referred to as the “Green Hell” – this is the rule of thumb – corresponds to the stresses of 13 kilometres on public roads. The course – very challenging topographically – is an indispensible instrument, especially in tuning all systems related to vehicle dynamics in the 918 Spyder. Of central importance here is the interplay between the active PASM damping system, fully variable aerodynamics, adaptive rear axle steering and the three motors of the parallel full-hybrid drive system. At the same time, the “Ring” motorsport course demands maximum loads from all components, especially drive and chassis components.

The Porsche 918 Spyder has the potential to break many records. The current target lap time for the North Loop of the Nürburgring is under 7:22 minutes. That is at least ten seconds faster than the Porsche Carrera GT. Even more important: the 918 Spyder surpasses previous models and competitors by far in its efficiency as well. As a plug-in hybrid vehicle, it systematically combines the dynamic performance of racing machine with over 795 hp and low NEDC fuel consumption, which – at about three litres fuel per 100 km – is better than that of most small cars today. In sum: maximum driving fun with minimal fuel consumption.

The 918 Spyder is already living up to its role as the legitimate successor to the Carrera GT, and it clearly surpasses that car’s driving performance – in terms of both acceleration and race track performance: Under three seconds for the sprint from zero to 100 km/h (Carrera GT: 3.9 seconds) and at least ten seconds faster than the best time for the Carrera GT of 7:32 minutes on the North Loop.

Carbon monocoque guarantees lightweight design with a low centre of gravity

The 918 Spyder utilizes the best state-of-the-art technologies to achieve its top performance. The load-bearing structure of its body consists of a monocoque with subframe – both are made of carbon fibre reinforced polymer (CFRP) for extreme torsional rigidity. Additional crash elements at the front and rear absorb and reduce the energy of a collision. The car's unladen weight of under 1,700 kg – an excellent low weight for a hybrid vehicle of this performance class – is largely attributable to this concept.

The drivetrain components and all components weighing over 50 kg are located as low and as centrally as possible within the vehicle. This results in a slightly rear end biased axle load distribution of 57 per cent on the rear axle and 43 per cent on the front axle, combined with an extremely low centre of gravity, which is ideal for driving dynamics. The central and low position of the traction battery directly behind the driver not only supports efforts to concentrate masses and lower the centre of gravity; it also provides the best temperature conditions for optimum battery functioning.

Chassis with race car genes and rear-axle steering

The Porsche 918 Spyder's multi-link chassis is inspired by motorsport design, complemented by additional systems such as the PASM adaptive shock-absorber system and rear-axle steering. Basically, this incorporates an electro-mechanical adjustment system at each rear wheel. The adjustment is speed-sensitive and executes steering angles of a few degrees in each direction. The rear axle can therefore be steered in the same direction as the front wheels or in opposition to them. At low speeds, the system steers the rear wheels in a direction opposite to that of the front wheels. This makes cornering even more direct, faster and more precise, and it reduces the turning circle. At higher speeds, the system steers the rear wheels in the same direction as the front wheels. This minimises "pressing" of the vehicle's rear end when changing lanes quickly. The result is very secure and stable handling.

Variable aerodynamics for different driving modes

A system of adjustable aerodynamic elements ensures unique and variable aerodynamics; its layout is automatically varied over three modes – ranging from optimal efficiency to maximum downforce – and is tuned to the operating modes of the hybrid drive system. Two of these modes are relevant for driving trials on the Nürburgring: In “Performance” mode, the retractable rear wing is set to a steep angle to generate high downforce at the rear axle. This is also supported by a spoiler positioned between the two wing supports near the trailing edge of the airflow. In addition, two adjustable air flaps are opened in the underfloor in front of the front axle, and they direct a portion of the airflow into the diffuser channels of the underbody structure. This also produced a “ground effect” at the front axle.

In “Sport” mode, the aerodynamic control system reduces the attack angle of the rear wing somewhat, which enables a higher top speed. The spoiler remains extended. The aerodynamic flaps in the underfloor area close, which also reduces aerodynamic drag and increases attainable vehicle speeds. In “E” mode, the control is configured entirely for low aerodynamic drag; the rear wing and spoiler are retracted, and the underfloor flaps are closed.

Adjustable air inlets under the main headlights round out the adaptive aerodynamic system. When the vehicle is stopped and in the “Performance” mode, they are opened for maximum cooling air intake. In the two other modes, they remain closed whenever possible to keep aerodynamic drag low. They not opened until the car reaches higher speeds or when cooling requirements are higher.

From comfortable to race-ready: five modes for three motors

The core of the 918 Spyder concept is its distribution of propulsive power among the three power units; their cooperation is controlled by an intelligent management system that offers five pre-selectable modes. This operating strategy is a core competency of the 918 Spyder. It ideally balances the different requirements between n efficiency-oriented driving profile and maximum performance. To best exploit these different approaches, the Porsche developers defined five operating modes that can be activated via a “map switch” on the steering wheel, just like in motorsport cars.

Quiet and elegant: “E-Power”

When the vehicle is started up, the “E-Power” mode is the default operating mode as long as the battery is sufficiently charged. In ideal conditions, the 918 Spyder can cover over 25 kilometres on purely electric power. In this mode, the combustion engine is only used when needed: maximum engine power is available at a moment’s notice by the kick-down function. If the battery’s charge state drops below a set minimum value, the vehicle automatically switches to hybrid mode.

Efficient and comfortable: “Hybrid”

In “Hybrid” mode, the electric motors and combustion engine work in varied configurations with a focus on maximum efficiency and minimum fuel consumption. The use of individual drive components is modified as a function of the current driving situation and the desired performance. The hybrid mode is typically used for a fuel economy-oriented driving style.

Sporty and dynamic: “Sport Hybrid”

In more dynamic situations, the 918 Spyder selects the “Sport Hybrid” mode for its power sources. The combustion engine now operates continuously and provides the main propulsive force. In addition, the electric motors provide support in the form of electric boosting when the operating point of the combustion engine can be optimised for greater efficiency. The focus of this mode is on performance and a sporty driving style.

For fast laps: “Race Hybrid”

“Race Hybrid” is the mode for maximum performance and an especially sporty driving style. The combustion engine is chiefly used under high load, and charges the battery when the driver is not utilising its maximum output. The electric motors provide additional support in the form of boosting, and the gear-shifting programme of the PDK is laid out for sportier driving. The electric motors are used up to the maximum power output limit to deliver the best possible performance for the race track. In this mode, the battery charge state is not kept constant, rather it fluctuates over the entire charge range. In contrast to Sport Hybrid

mode, the electric motors run at their maximum power output values for a short time for better boosting. This increased output is balanced by the combustion engine charging the battery more intensively.

For pole position: "Hot Lap"

The "Hot Lap" button in the middle of the map switch releases the 918 Spyder's final reserves and can only be activated in "Race Hybrid" mode. Similar to a qualification mode, this pushes the traction battery to its maximum power output limits for a few fast laps. This mode uses all of the available energy in the battery.

Main propulsion: the race car's eight cylinder engine

The main source of propulsion is the 4.6-litre, eight cylinder engine that produces over 580 hp of power; it was derived directly from the power unit of the successful RS Spyder, which explains why it can deliver engine speeds of up to 9,000 rpm. Like the RS Spyder's race engine, the 918 Spyder power unit features dry-sump lubrication with a separate oil tank and oil extraction. To save weight, components of the air filter box and air induction are made of carbon fibre reinforced polymer. Further extensive lightweight design measures has resulted in such features as titanium connecting rods, thin-wall, low-pressure casting on the crank case and the cylinder heads, a high-strength, lightweight steel crankshaft and the extremely thin-walled alloy steel exhaust system. Weight and performance optimisations achieve a power output per litre of approx. 126 hp/l, which is significantly higher than that of the Carrera GT (106 hp/l) and outstanding for a naturally aspirated engine.

Unique race car design heritage: Top Pipes

It isn't just this engine's performance but also the sound it makes that stokes the emotionality of the 918 Spyder. This is attributable first and foremost to the so-called top pipes: the tailpipes terminate in the upper part of the rear end immediately above the engine. No other production vehicle uses this solution. The top pipes' greatest benefit is optimal heat rejection, because the hot exhaust gases are released via the shortest possible route, and

exhaust gas back pressure remains low. This design requires a new thermodynamic air channelling concept: With the HSI engine, the hot side is located inside in the cylinder V, the intake channels are on the outside. There is another benefit as well: the engine compartment remains cooler.

This is especially beneficial to the lithium-ion hybrid battery, as it provides optimum performance at temperatures between 20 and 40 degrees Celsius. Consequently, less energy needs to be used for active cooling of the battery.

In parallel in the drivetrain: hybrid module

The V8 engine is coupled to the hybrid module, since the 918 Spyder is designed as a parallel hybrid like Porsche's current hybrid models. Essentially, the hybrid module comprises a 95 kW electric motor and a decoupler that serves as the connection with the combustion engine. Because of its parallel hybrid configuration, the 918 Spyder can be powered at the rear axle either individually by the combustion engine or electric motor or via both drives jointly. As is typical for a Porsche super sports car, the power pack in the 918 Spyder has been placed in front of the rear axle, and does not have any direct mechanical connection to the front axle.

Upside-down for a low centre of gravity: Doppelkupplungsgetriebe (PDK)

A seven-speed Doppelkupplungsgetriebe (PDK) transmission handles power transmission to the rear axle. The high-performance transmission, which is based on the PDK in the 911 Turbo, has undergone a complete redesign for the 918 Spyder and was further optimised for high performance. To ensure a low mounting position for a low centre of gravity of the entire vehicle, the gear unit was turned "upside down" by rotating it 180 degrees about its longitudinal axis, in contrast to the mid-engine two-seat Boxster, for example. If no power is required on the rear axle, the two motors can be decoupled by opening the decoupler and PDK clutches. This is the action behind the Porsche hybrid drive's typical "coasting" with the combustion engine switched off.

Independent all-wheel drive: front axle with electric motor

On the front axle, there is another independent electric motor with an output of approximately 85 kW. The front electric drive unit drives the wheels at a fixed ratio. A decoupler decouples the electric motor at high speeds to prevent the motor from over-revving. Drive torque is independently controlled for each axle. This makes for very responsive all-wheel drive functionality that offers great potential in terms of traction and driving dynamics.

Lithium-ion battery with plug-in charging system

The electric energy for the electric motors is stored by a liquid-cooled lithium-ion battery comprising 312 individual cells with an energy content of about seven kilowatt hours. The battery of the 918 Spyder has a performance-oriented design in terms of both power charging and output, so that it can fulfil performance requirements of the electric motor. The power capacity and the operating life of the lithium-ion traction battery depend on several factors, including thermal conditions. That is why the 918 Spyder's battery is liquid-cooled by a dedicated cooling circuit.

To supply it with energy, Porsche developed a new system with a plug-in charging interface and improved recuperation potential. The plug-in interface in the B-column on the front passenger side lets users connect the storage battery to a mains supply at home and charge it. The charging interface is standardised for the country of purchase. The charger is located close to the traction battery. It converts the alternating current of the mains supply into direct current with a maximum charge output of 3.6 kW. Using the supplied charging cable, the battery can be charged within four hours from a ten ampere rated, fused power socket on the German 230 Volt mains supply, for example. A compact charging station is also supplied as standard with the 918 Spyder. It can be installed permanently in the driver's garage and enables rapid and convenient charging within approximately two hours, irrespective of regional conditions.

Three-fold energy recovery: recuperation

In order to convert the kinetic energy of the vehicle into electric current when braking much more effectively than in today's vehicles, developers created a new generation of the energy recuperation system. A modern-day Porsche hybrid recovers braking energy up to a deceleration of 0.15 g. That corresponds to a braking manoeuvre in which the driver applies approximately 1.5 kg of pedal force. The 918 Spyder can recover up to 0.5 g, equating to eleven kg of pedal force – that is over three times as much energy. The 918 Spyder use both electric motors to brake and thereby recuperate energy for the traction battery. The super sports car features a ceramic braking system (PCCB) as standard.

Pioneering control concept: clear organisation of the cockpit

The driver is the focus of all technology in the future Porsche super sports car. A cockpit was created for the driver that is typical of the brand and pioneering in its clarity. It is partitioned into two basic areas. First, there are the controls that are important for driving, which are grouped around the multifunction steering wheel, combined with driver information displayed on three large round instruments. Second, there is the infotainment block that is housed in the lifted centre console, which was introduced in the Carrera GT. Control functions, e.g. for the automatic climate control system, seat adjustment lighting and Porsche Communication Management (PCM), can be intuitively operated by multitouch in a new type of black panel technology.

For even higher performance: the Weissach package

For very performance-oriented customers of the 918 Spyder, Porsche offers the "Weissach" pack as an option. These modified super sports cars can be recognised at first glance by special colours and designs that are based on legendary Porsche race cars. The roof, rear wings, rear-view mirrors and frames of the windscreen are made of visible carbon. Parts of the interior are upholstered with Alcantara instead of leather, and visible carbon replaces much of the aluminium. The emphasis on performance is not just visual: very lightweight magnesium wheels reduce unsprung masses; gross weight was reduced by about 35 kg. The benefits are experienced in further improved dynamic performance. Other references from motorsport include flame-resistant seat covers and six-point seatbelts for driver and front passenger.

Porsche redefined: a new super sports car for a new decade

The 918 Spyder continues a long tradition of super sports cars at Porsche; as technology platforms, as the driving force behind both car emotion and car evolution and as the ultimate sports cars of their decades: the Carrera GTS, the first Porsche Turbo, the 959, the 911 GT1, the Carrera GT. More than any of its predecessors, the 918 Spyder is providing a critical impetus to developing technologies for future vehicle concepts. In sum, it offers a complete package of components that reflect Porsche DNA – more concentrated than ever before.

Facts: North Loop of the Nürburgring

Location:	Germany's "Eifel" region approx. 90 km southwest of Cologne
Built in:	1927
Course length:	22.832 km
Bends:	73, of which 40 are right turns and 33 are left turns
Inclines:	up to 17 per cent
Descents:	up to 11 per cent
Highest elevation:	616.8 metres above sea level in "Hohe Acht" section
Lowest elevation:	320 metres above sea level in "Breitscheid" section
Height difference:	just about 300 metres
Course record:	6:11.13 minutes by Stefan Bellof 1983 in a Porsche 956C
Last Formula-1 race:	1 August 1976, won by James Hunt in a McLaren Ford in 1:41:42.7 (hours:minutes:seconds)

The North Loop of the Nürburgring is considered one of the most difficult motorsport courses in the world. Between 1951 and 1976 it was also one of the most feared Formula-1 race courses. Numerous accidents and many deaths confirm the high demands it places on drivers. For safety reasons, the North Loop was discontinued as a race course for Formula-1 racing back in 1976. It was not economically feasible to modify the traditional course that is over 20 km in length. Today, races are still held with touring cars and GT vehicles. The 24-hour race that is held each year is well-known across the world. Along with the classic Le Mans race of the same length, it is considered one of the toughest tests of man and material.

The name “Green Hell” comes from Jackie Stewart, inspired by the hedges lining the course until 1970. Right after it was opened, the course was available for use at a fee – even by private individuals – on non-racing weekends and during the evening hours. Since its opening, carmakers have also used the first “hill, race and test course” with its many curves, descents and jump hills for extensive test drives. Development engineers consider the stresses on cars to be 13 times as great. This means that one kilometre on the North Loop stresses a car as much as 13 kilometres on a normal public road.

Specifications of the Porsche 918 Spyder

Body:	Two-seat Spyder; carbon fibre reinforced plastics (CFRP) monocoque interlocked with CFRP unit carrier; two-piece Targa roof; fixed roll-over protection system.
Drivetrain:	Parallel full hybrid; 4.6-litre V8 mid-engine with dry-sump lubrication; hybrid module with electric motor and decoupler; electric motor with decoupler and gear unit on front axle; auto start/stop function; electrical system recuperation; four cooling circuits for motors, transmission and battery; thermal management.
Engine power:	580 hp (426 kW) at 8,500/min (V8 engine) 95 kW (hybrid module on rear axle) 85 kW (electric motor on front axle) 795 hp (combined)
Max. torque:	500 Nm at 6.500/min (V8 engine) 780 Nm from 1,000/min to 4,000/min (combined)
Maximum Revs:	9,000 rpm
Power output per l:	126 hp/l (V8 engine)

Power transmission: Combustion engine with hybrid module and transmission bolted together to form a single drive unit; seven-speed Doppelkupplungsgetriebe (PDK); rear-wheel drive; front electric motor with gearbox for driving the front wheels (decoupled from 235 km/h); five pre-selectable operating modes for optimum coordination of all drive units.

Gear ratios	PDK
1st gear	3.91
2nd gear	2.29
3rd gear	1.58
4th gear	1.19
5th gear	0.97
6th gear	0.83
7th gear	0.67
R gear	3.55
Final drive ratio	3.09
Clutch diameter	220 mm / 164 mm

Chassis and Suspension: Double-wishbone front axle; optional electro-pneumatic lift system on front axle; electro-mechanical power steering; multi-link rear axle with adaptive electro-mechanical system for individual rear wheel steering; electronically controlled twin-tube gas-pressure dampers in the front and rear with Porsche Active Suspension Management (PASM).

Brake system: High-performance hybrid brake system with adaptive recuperation; internally ventilated and perforated front ceramic brake discs (PCCB), 410 mm in diameter and 36 mm thick; rear discs 390 mm in diameter and 32 mm thick.

Wheels and tyres: 918 Spyder wheels
(Weissach package: 918 Spyder magnesium wheels)

front	9.5 J x 20	with	265/35 ZR 20
rear	12.5 J x 21	with	325/30 ZR 21

Weights:	Curb weight, DIN		1,700 kg (Weissach package: 1,665 kg)
Dimensions:	Length		4,643 mm
	Width		1,940 mm
	Height		1,167 mm
	Wheelbase		2,730 mm
	Track width	front	1,664 mm
		rear	1,612 mm
	Luggage compartment capacity, VDA		~110 l
	Fuel tank capacity		70 litres
Energy supply:	Lithium-ion battery with 6.8 kWh capacity (BOL nominal), 200 kW maximum power and mains-compatible plug-in charger.		
Performance:	Top speed		325 km/h
	purely electric		150 km/h
	Acceleration:		
	0 – 100 km/h		3.0 s
	0 – 200 km/h		9.0 s
	0 – 300 km/h		27.0 s
Consumption (NEDC):	Total		3.0 l/100 km
CO_2 emissions:	Total		70 g/km
Range:	Purely electric		25 km
Warranty:			4 years