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From the Lohner-Porsche to the 911 Turbo

One of the first cars to feature all-wheel drive was a Porsche, and it was a sports car: Ferdinand Porsche designed and built the Lohner-Porsche racing car with four electric wheel-hub motors.



In 1947, Porsche developed the Type 360, better known as the Cisitalia racing car. It became legendary not only because of its twelve-cylinder supercharged engine and the lightweight construction throughout, but also because of its part time all-wheel drive. This design was again based on the idea that, on bends or on road surfaces with low coefficients of friction, drive power can be fully and safely transformed into propulsion.

In 1981, Porsche began using all-wheel drive for non-racing cars. At the International Motor Show in Frankfurt, the company presented the study of a 911 Turbo Cabriolet with all-wheel drive. In 1984, Porsche revisited the idea and designed the Type 953 with part time all-wheel drive for the Paris-Dakar Rally, at which it promptly took overall victory. Experiences with the 953 led to the 959 super sports car being manufactured; it was launched in 1985 and was really ahead of its time in terms of its overall technology. With front-wheel drive that engaged via the multi-plate clutch and a rear differential lock also actuated via the multi-plate clutch, it created the basic concept for the Porsche all-wheel drive. These center-differential lock and rear differential locks were actuated both manually and automatically. The concept is still a feature of PTM today. The double victory of the Porsche 959 at the 1986 Paris-Dakar Rally is legendary.

911 Carrera 4: The first 911 with all-wheel drive made its debut 30 years ago



The 911 Carrera 4 from 1988

The manner of adjustment was innovative. Slippage at individual wheels was detected by the ABS sensors and prevented by hydraulic locks. Two electronically controlled multi-disc locks controlled the flow of forces to the front axle and between the wheels of the rear axle. The effect: Permanent optimisation of traction and driving stability, handling on bends, and load change response.

1994: New all-wheel drive system with viscous coupling – hang-on instead of permanent all-wheel drive

In 1994, Porsche resumed development of the all-wheel drive with the 993 generation 911 Carrera 4. The 911 Turbo now also used all four wheels to transmit power for the first time. With both models, Porsche switched to a simpler system design, which helped it to launch the lightest all-wheel drive system on the market at that time. The system was designed as a hang-on all-wheel drive, with the rear axle being directly driven and, in the event of speed differences between the front and rear axles, a passive viscous coupling that transmitted some of the propulsion force to the front axle. So the viscous coupling replaced the transfer case and controlled multi-plate clutch for the front axle drive. As a result, the all-wheel drive 911 was effectively dominant to the rear when under load, in a similar way to a rear-wheel drive but much more stable. A conventional differential lock and an automatic brake differential (ABD) were used on the rear axle.

The role of the viscous coupling was to automatically distribute drive torque between the axles, depending on slip at the rear wheels. The ABD built into the all-wheel drive model as standard used the ABS sensors to detect the slip at the individual wheels and provided a corresponding braking torque at the spinning wheel via the control unit. With different coefficients of friction on the right and on the left, the propulsion force was initially moved continuously by the rear axle differential lock to the wheel with increased power transmission. If a wheel began to spin, it was decelerated by the ABD, and drive torque at the level of the braking torque was transmitted to the opposite wheel. This feature was particularly helpful to the driver when experiencing problems starting the vehicle on wet or slippery road surfaces.

Porsche stuck with this concept for the Type 996 911; the difference was that the viscous coupling ran in the oil bath of the front axle drive unit and was therefore effectively cooled even under high load. The transaxle tube was omitted from the 996 generation due to weight and in order to create space for the water cooling pipes. Instead of a rigid connection between the transmission fastened directly to the engine and the front axle drive unit (via a central tube), drive was supplied to the front axle via an exposed cardan shaft.

2002: The Cayenne introduces Porsche Traction Management (PTM)

In 2002, Porsche presented the Cayenne as a third model line – and it featured completely new all-wheel drive technology. In basic

mode, Porsche Traction Management (PTM) transmitted 62 per cent of engine power to the rear wheels and 38 per cent to the front wheels. However, using an electronically controlled multi-plate clutch operated by an electric motor as a variable centre-differential lock, it was possible to vary the distribution ratio according to the driving situation and so actively influence longitudinal and lateral dynamics. In addition, a rocker switch made it possible to manually engage a centre-differential lock for intensive off-road use. PTM had a decisive influence on the driving dynamics of the Cayenne. The map-controlled centre-differential lock and an optional rear differential lock didn't simply respond to a lack of traction at the front or rear axle. In addition, sensors also detected vehicle speed, lateral acceleration, steering angle and accelerator control, so that PTM was able to calculate the optimum degree of lock for both axles and assign the necessary drive torque to the axles. PTM was therefore a forward-looking system that delivered great agility when taking bends and excellent driving stability when changing lanes, both at high speeds and when driving more slowly on ice and snow.

The first PTM for the Porsche 911



The 911 Turbo from 2006

With a maximum response time of 100 milliseconds, PTM responded more quickly to load change than the engine and the driver did. In practice, this meant: Great agility on narrow country roads, outstanding traction and incredibly safe driving, even when carrying out extreme driving manoeuvres at high speed. In order to perform these dynamic driving tasks, the Porsche designers programmed PTM with five key basic functions; to this day, the Porsche all-wheel drive still essentially works on these principles:

Basic torque distribution: In everyday driving, the control system continuously distributes engine torque between the front and rear axles in accordance with the current driving situation by engaging the front axle drive in a defined way. For this purpose, the torque required at the front axle is determined on a millisecond basis. If the system detects a lane change, for example, it engages the front-wheel drive to a greater or lesser extent based on the speed. The driver will experience this as a significant increase in stability, especially at very high speeds.

Guided control: Using typical parameters, PTM is able to detect dynamic changes to the driving status at an early stage and avoid slip in advance. When starting the car, for example, the system determines how fast the driver is accelerating. Even before the engine can translate this request to accelerate into torque, the PTM locks the multi-plate clutch enough to prevent the wheels from spinning as much as possible. Only in extreme cases, such as when both rear wheels are grinding on sheet ice without any traction, is enough engine torque transmitted to the front wheels to cause them to spin. This means that, even when starting the vehicle, all four wheels are under the greatest possible propulsion force and optimum acceleration is achieved. An exception to this is a racing start via "Launch Control" in conjunction with the PDK transmission. If this is required, PTM locks the multi-plate clutch before the vehicle is started in order to guarantee maximum traction.

Slip controller: Due to its high torque, a 911 is able to reach the traction limit of the rear axle in a short burst of speed, especially on a

wet road surface. More torque and therefore propulsion force is transmitted to the front axle through stronger engagement of the multi-plate clutch. It was in 2006, that the 911 Turbo first featured this detection and control of longitudinal acceleration.

Oversteer correction: If the rear end of the vehicle pushes outwards on a bend due to disruptive influences such as wet leaves, greater propulsion force is transmitted to the front axle in order to stabilise the vehicle in a dynamic way. A further benefit of PTM is the way in which the steering angle is taken into account when distributing power to the front axle. If the driver countersteers to correct an oversteer, PTM adapts the propulsion force to the front axle and the vehicles stabilises even more quickly.

Understeer correction: On the other hand, if the front wheels of the sports car are pushing out of the bend, PTM reduces the torque to the front axle. In both cases, PTM uses the precision sensors to respond before the driver has even noticed any instability. The result is fast, active stabilisation of the vehicle for efficient and dynamic driving on bends, as there are fewer braking interventions at individual wheels by the PSM stability system.

Panamera and Macan with all-wheel drive like sports cars



The Macan Turbo from 2013

Porsche all-wheel drive development

The latest Porsche Traction Management (PTM) used in the 911 is the very embodiment of sporty all-wheel drive. Its intelligent nature improves agility on bends, stability when performing highly dynamic manoeuvres, and traction. PTM represents the current pinnacle of how all-wheel drive has evolved in Porsche series-production sports cars over more than 30 years. Porsche all-wheel drive has its roots in motor racing. In 1984, it helped the Type 953 to win the Paris-Dakar Rally; in 1986, the 959 super sports cars with electronically controlled variable all-wheel drive celebrated a double victory.

1988: World premiere of the electronically controlled all-wheel drive in the 911 series-production model

The first 911 road vehicle with all-wheel drive as standard celebrated its world premiere in 1988. The Type 964 Porsche 911 Carrera 4 used a planetary gear set as a centre differential to distribute propulsion force. In addition, multi-disc locks were placed between the front and rear axles (as a centre-differential lock) and on the rear axle (as a controlled differential lock).

1994: Second generation with passive hang-on system

Porsche presented the second-generation all-wheel drive in 1994, in the Type 993 911. The system was constructed as a hang-on all-wheel; if there is a difference in speed between the directly driven rear axle and the front axle, a passive viscous coupling transfers some of the propulsion force to the front axle. This system was transferred virtually unchanged for use in the 996 generation 911 Carrera and 911 Turbo models.

2002: Porsche Traction Management premieres in the Cayenne

The era of Porsche Traction Management began in 2002 with the Cayenne. At this point, PTM is a permanent all-wheel drive system with a central transfer case that distributes propulsion force to the front and rear axles at a ratio of 38:62. In addition, a reduction gear and an electronically controlled centre-differential lock deliver full off-road capability, as you would expect for an SUV. The first PTM also impressed with its driving dynamics capabilities.

2006: The first 911 with PTM

In 2006, with the Type 997 911 Turbo, Porsche presented a PTM version that had been enhanced specifically for sports cars; it featured an electronically controlled and electro-magnetically actuated multi-plate clutch with ball ramp reinforcement. This active, fully variable system distributes propulsion force between the permanently driven rear axle and the front axle much more quickly and accurately than the passive viscous coupling used in the previous version. In 2008, this system was also used in the 911 Carrera 4 models of the second generation of 997; in the first generation, they still had the all-wheel drive with viscous coupling.

2009 and 2013: Panamera and Macan with 911 technology

The all-wheel drives of most Panamera models (from 2009) and all Macan versions (from 2013) also have a controlled multi-plate clutch. The control strategy is based on that of the 911 and as such helps to ensure that the Panamera and Macan deliver best-in-class driving dynamics that are typical of a sports car.

2013: Latest PTM – even more efficient

The latest, most advanced, PTM version was first put to use in 2013 in the 911 Turbo of the first 991 generation. In contrast to the previous system, which was used with the 911 Carrera 4 models right up to the second generation of the 991 in 2015, the newly developed multi-plate clutch is now controlled electro-hydraulically rather than electro-mechanically. This has advantages in terms of performance thanks to faster and more accurate control of propulsion force in relation to traction, driving stability and steerability.

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