

**The Lenz PowerKat® System for Porsche 911 Carrera 2/4 Baujahr 1990-1993****1. The Porsche 911 Carrera 2/4**

At the latest with the 911 Carrera 1, produced almost unchanged from 1984 – 1989, the last icon of the so-called cast-iron ones, the call of the market for a technically modernized successor had become unmistakable. The antiquated suspension technology without ABS and not the least at that time the painful power losses of the insurmountable catalyst technology exhaust hurdles required urgent remedy. Porsche had demonstrated in the meantime with the technology carrier 959, what potential the 911 idea has.

Thus for the 25<sup>th</sup> anniversary of the 911, the Carrera 4 first appeared with all-wheel drive, and then later the 911 Carrera 2 version with classical rear-wheel drive. Beneath an outwardly little changed form, a thorough technical evolution of the proven and successful 911 was hidden. With substantially improved suspension, ABS, power steering, effective heating, airbags and an engine with 250 HP from 3,6 liters increased displacement with now up-to-date catalyst technology, again adequate technology according to current conditions was offered. More still than with the improved road performance, new dimensions in the handling characteristics were realized.

As is the case for each Porsche, increased performance is also a popular topic with the 911 Carrera 2/4. And the technical basis of the 911 Carrera 2/4 is outstandingly suitable for such measures. With particularly developed, coordinated system components according to today's conditions of engine technology most attractive increases in output up to 340 HP can be realized with the 911 Carrera 2/4.

The newly developed Lenz PowerKat ® system performs exactly this. The use of most modern technology with the Lenz KatTronic ® digital engine management, sport metal catalyst and the Lenz

PowerFlow ® adjustable exhaust system now makes it possible to realize substantially improved performance development in comparison to the base engine. This technical update of the engine to today's conditions of engine technology places a meaningful investment into the value retention of the 911 Carrera 2/4, which is particularly recommended especially regarding the substantially increased driving fun with moderate values consumed.

With the Lenz PowerKat ® system the 911 Carrera 2/4 achieves a technological and performance-related connection to the following Carrera generations, and this with up-to-date consumption and exhaust values. Our slogan *classic meets future* stands for this successful synthesis of automotive classic with high tech.

## **2. The requirement: Performance with PowerKat**

The Lenz PowerKat ® system is conceived as an uncompromising high end system for the increase in performance of high performance engines. It was developed with the philosophy to optimize, using most modern technology, the engine in the characteristics performance development, consumption economics and pollutant behavior in relation to the series.

The system was optimized compared to the base engine regarding the critical parameters dynamic response mode, specific consumption, torque development, engine performance and acceleration capacity according to most modern conditions of the engine control technology. In sum an excellent efficiency and a convincing total performance are obtained.

## **3. The technical realization – performance optimization**

The 911 Carrera 2/4 is equipped with Bosch Motronic as the engine management system for injection and ignition. The load evaluation in the series engine takes place by means of an air intake flap in the intake manifold (air intake flap and air meter).

Basis of the development is a careful analysis of the vibration response of the engine on the intake and exhaust side. For this, extensive measurements on the Lenz Motorentechnik GmbH engine test stand were performed. Thereupon the basic adjustment of the system components took place in the stationary position. The dynamic driving behavior was optimized in numerous measuring sessions. Many years of experience in motorsport flowed into the tuning realizations, which resulted altogether in a performance optimized overall system.

Principle item of the Lenz PowerKat.® retrofit kit is the Lenz KatTronic ® digital engine management, with connector and pin-compatibility which is used in place of the Bosch Motronic. The load measurement is done by alpha / n, successfully proven in racing, which permits a substantially larger intake diameter in comparison to the flap and in connection with a venturi tube supports dynamic effects of the load change.

The intake side of the 911 Carrera 2 exhibits still some reserves for performance optimization. Through the alpha / n system, a substantially larger intake diameter is used, the structuring of the intake manifold as an accurately computed venturi tube strengthens the dynamic effects with the load change. An optimized throttle body rounds out the intake side measures.

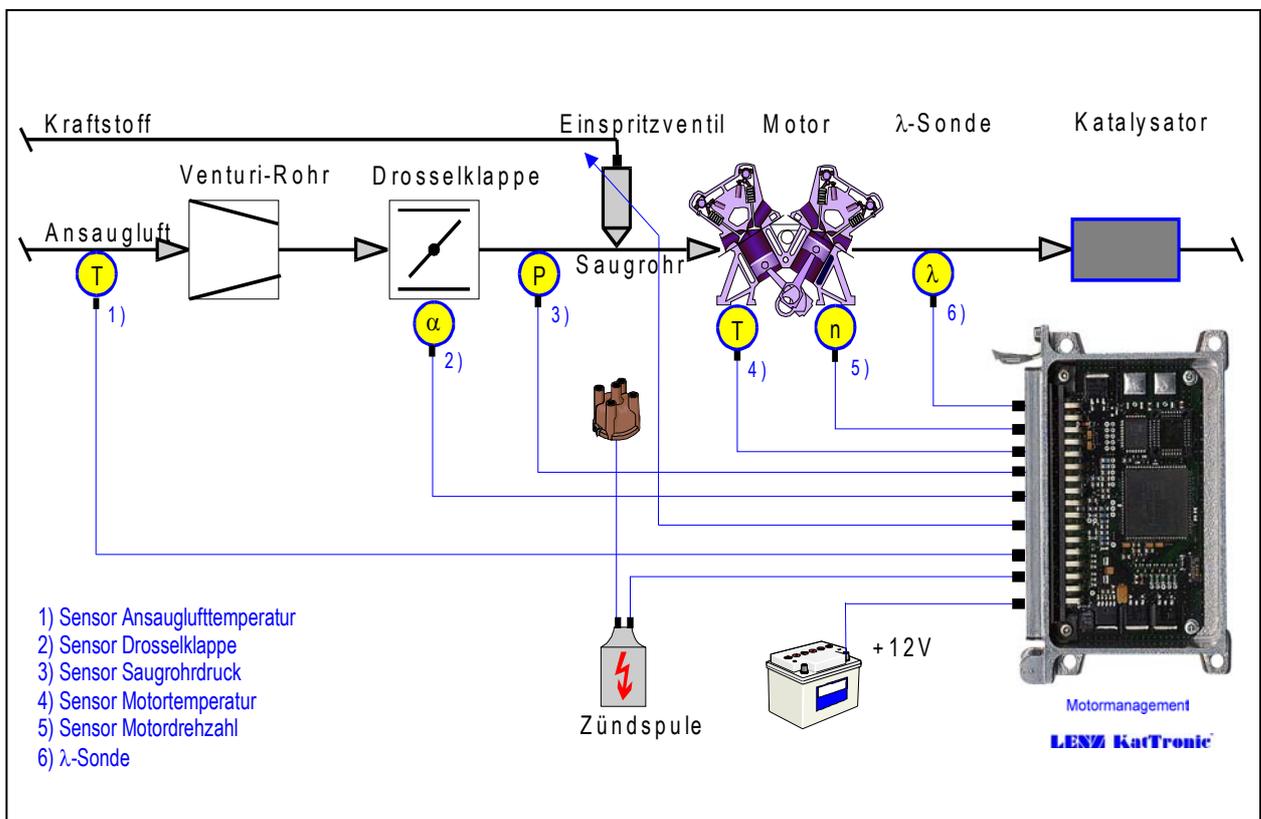
On the exhaust side, an effective flow improvement takes place via use of low-resistance sport metal catalysts. The exhaust manifolds are designed as length and diameter optimized headers, which for each cylinder bank lead into a separate catalyst. Thus the vibration response on the exhaust side is optimized. The final muffler contains the Lenz PowerFlow ® variable adjustable exhaust system, with which dependent on rpm and load, the engine management via electro-pneumatic flaps, selects different exhaust passages. Thus the torque development in a broad rpm range is substantially improved.

For the realization of an optimum performance yield other cam shafts with adapted timing are used. The performance potential of the technical modifications on the intake and exhaust side is only completed by the optimal tuning of injection amount and ignition degree for each number of rpm and load with consideration to the precise engine operational data. Compared to the series engine, the injection amount for the two cylinder banks is separately executed and regulated over separate Lambda probes (stereo lambda regulation).

**4. System structure**

The engine specific adaptation of Lenz KatTronic® to the existing injection system is effected through particularly developed and adapted sensor/actuator components. For the precise collection of the engine operating condition high-quality, select sensors are used.

**Adaption Lenz KatTronic® for 911 Carrera 2/4**

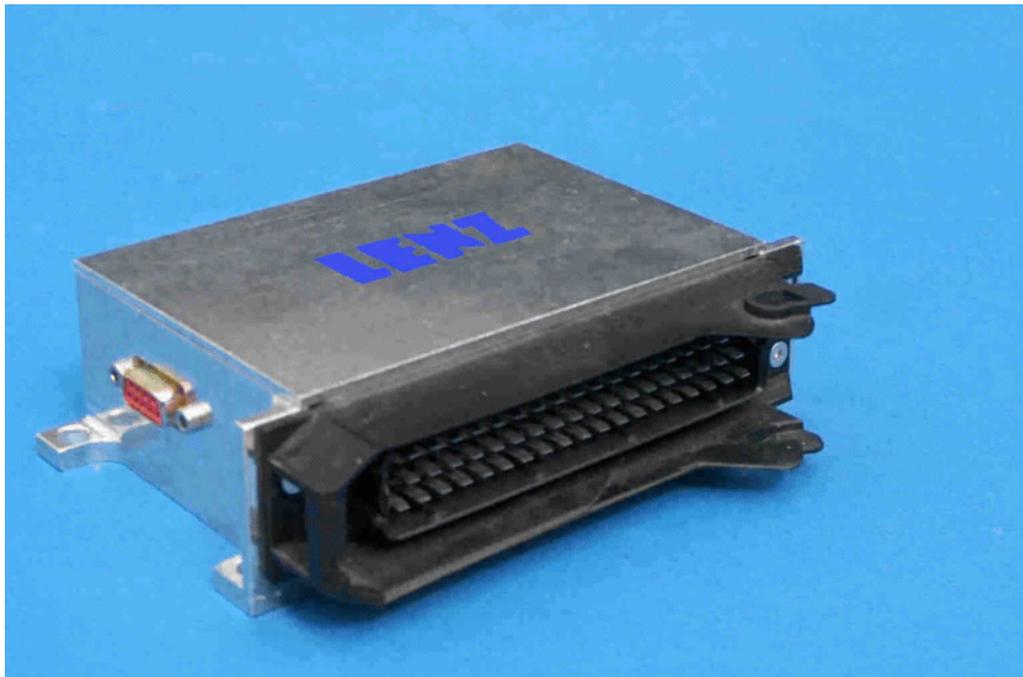


**5. The Lenz KatTronic® engine management**

Lenz KatTronic® is a modern, modular developed digital engine management for ignition and injection with the Infineon Microcontroller C509 as CPU. The storage of the data tables / maps and control parameters takes place in flash memories. A special, hardware-supported signal processing makes possible the ultra fast and highly exact dissolution of the sensor data and a high system throughput. The system software works real-time, i.e. each injection and ignition event is calculated up to the maximum permissible engine speed in real time from the sensor data and operating conditions. The result is a delay-free adjustment of the engine control to the respective operating condition. Special algorithms have been integrated in the control software for optimization of the dynamic behavior. The Lambda regulation works according to a modified PID algorithm practically delay-free over the entire load / rpm spectrum, the reference is derived from a lambda data table / map with

additional operating specific corrections. The regulation works adaptively, i.e. from the measured values of the lambda sensors, model values are derived, which are stored in an adaptation data table / map. In the long-term operation performance data are kept on a constant level by continual updating of engine electronics. On board diagnostic routines permanently monitor the function of the sensor technology and store abnormal operating conditions as well as implausible sensor data for diagnostic purposes. A fail-safe program permits driving in the event of an error. A temperature-dependent speed limiter protects the engine during the warming-up phase against excessive wear by too high rpms.

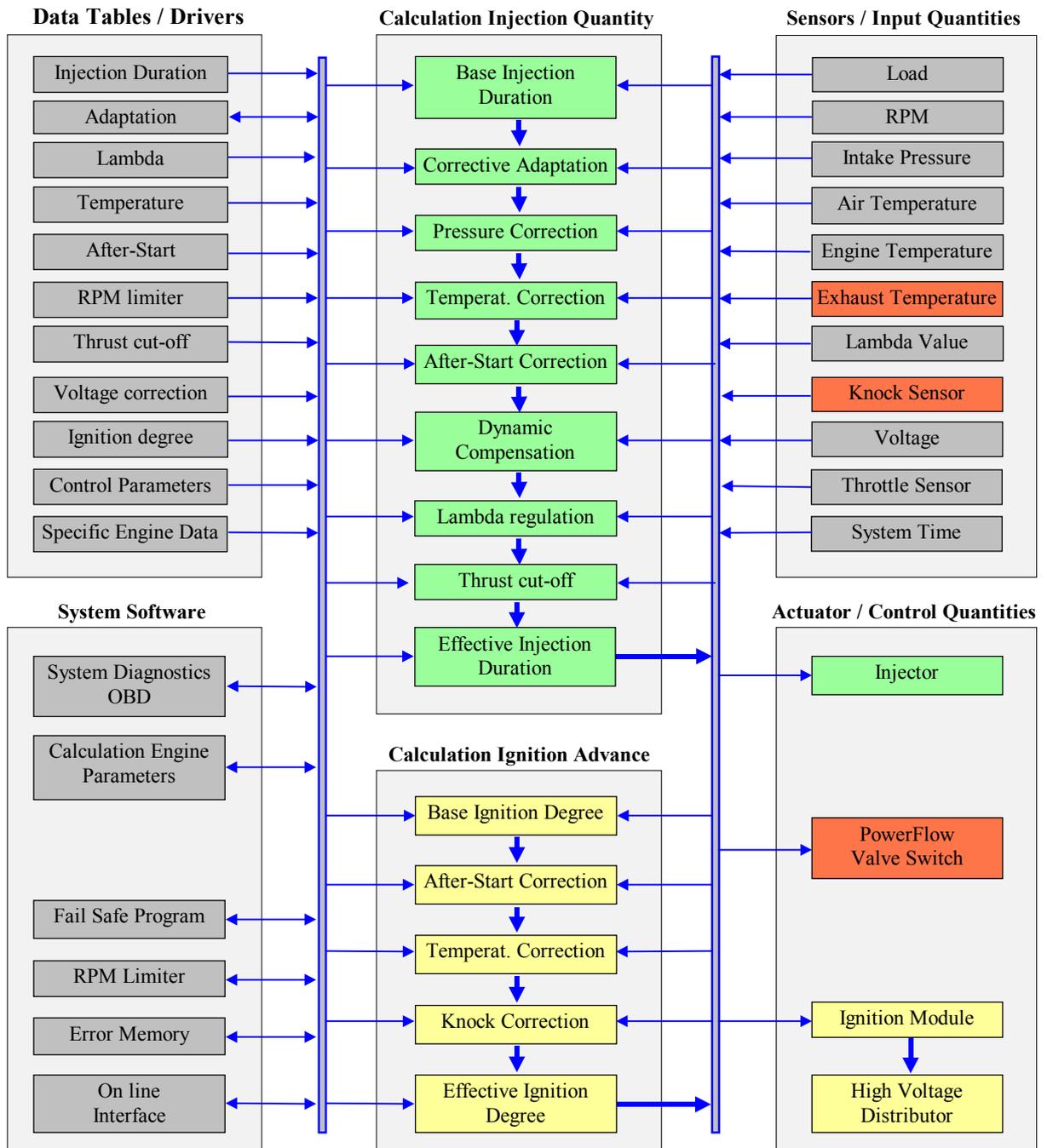
Future pollutant standards as well as performance improvements in the course of continuing development can be realized as updates to the operational software problem-free. Therefore the Lenz KatTronic<sup>®</sup> is a future-safe investment.



**See picture of controller**

The engine management is connector and pin compatible to the standard Bosch Motronic controller. The structure is executed in modern SMD technology according to EMV guidelines.

**Functional Structure of the Lenz Katronic® Engine Management System**



**Overview of the Lenz KatTronic® engine management**

**Input Values**

Intake Manifold Pressure  
 Engine Temperature  
  
 Air Temperature  
 Lambda Sensors  
 Exhaust Gas Temperature  
 Throttle Butterfly position  
 Rpm Sensor  
 Knock Sensor

**Output Values**

Idle  
 Injection  
  
 Ignition  
 Fuel Pump  
 Boost Regulation

**Data Tables / Maps**

Injection  
 Lambda Value  
  
 Ignition degree  
 Lambda regulation  
 Adaptation  
 Boost Pressure  
 Load Evaluation

**Data Table Drivers**

Lambda Sensor  
 Engine  
 Temperature  
 Air Temperature  
 Warm Up  
 Start Quantity  
 After-Start Factor  
 Voltage Correction

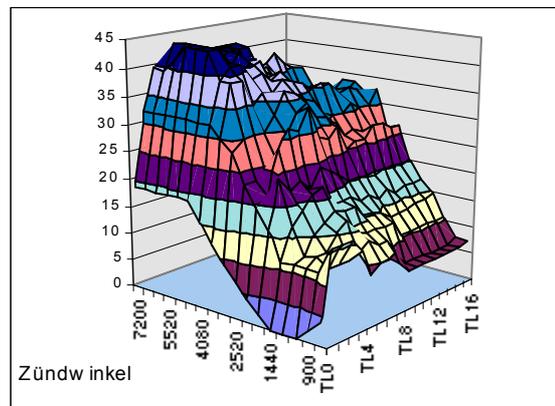
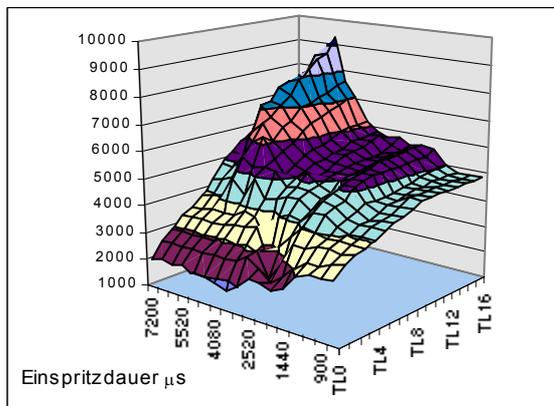
**Base Functions**

Warm Up  
 Idle Regulation  
 Temperature Dependent Thrust reduction  
 Temperature Compensation  
 Dynamic Transition Compensation  
 Boost Control  
 Asymmetrical PID Lambda Regulation

**Monitoring Functions**

fail-safe Program  
 Sensor Monitoring  
 Operating Hour Counter  
 Temperature Dependent Speed Limiter  
 Error Memory  
 Extreme Value Memory  
 Serial Interface (RS-232)

**Data tables / maps for injection correction and ignition degree**



**6. The Lenz KatTronic® software**

A singular feature of the Lenz KatTronic ® is the integrated serial interface to standard PC (operating system MSDOS) executable software. In the standard design important system data can be displayed on-line in current driving conditions on a graphic display as well as on a PC or laptop with Windows/MS DOS and diagnostic data for service purposes be read out. For the professional application an extended version is available. This contains functions for system calibration as well as the on-line editing of the data tables / maps and system parameters, with which an individual fine tuning is possible on the respective engine. Further on-line measuring data can be recorded and changes be made (data recording / telemetry).

The on-line measuring date display

Allgemein	Kenndaten	Laden	Speichern	Messdaten	Drucken
Drehzahl . . . . . :	0 U/min			Zündungsdaten _____ P911C2A.ZKF _____	
Drosselklappe . . . . . :	0 %			Startwinkel . . . . . :	0.0 °
Saugrohrdruck (abs) :	956 hPa			Motortemp. Korr. . . . . :	5.3 °
T1 / n - Stützst. . . . . :	1.6 / 840			Lufttemp. Korr. . . . . :	0.0 °
				Zündwinkel (eff.) . . . . :	5.3 °
Batteriespannung. . . . :	12.57 V			Einspritzdaten _____ P911C2A.EKF _____	
Ladezeit Z-Spule. . . . :	3.1 ms			Anlaß-Einspritzzeit. . . :	6000 µs
Spannungskorr. EV. . . . :	1.8 ms			Nachstartfaktor. . . . . :	1.00
				Motortemp. Korr. . . . . :	1.00
Motortemperatur. . . . . :	47 °C			Lufttemp. Korr. . . . . :	1.00
Lufttemperatur T1 . . . . :	20 °C			Saugrohrdruck-Korr :	1.00
				Einspritzzeit (eff.) . . . :	6.00 ms
					0.00 ms
				Einspritzmenge. . . . . :	0.00 g / s
Geschwindigkeit. . . . . :	0 km/h	G: 0	Lam 1 0.80 [----]	(deakt.)	
		S: 0		(deakt.) AKF	
			Lam 2 0.80	(deakt.)	
P4.5 HI P4.7 HI				1.00 Fak. B2	
fehlende Zähne . . . . . :	60		<R>ec. ist AUS	<V>S ist AUS	
LENZ Motorentechnik					

7. System components

The system Lenz PowerKat® for the Porsche 911 Carrera 2/4 consists of the following components:

**310 HP - Basis Lenz PowerKat® system**

- sport metal catalyst
- air temperature sensor
- throttle position sensor
- intake manifold pressure sensor
- enlarged interference throttle body
- Lenz KatTronic® engine management system.

**340 HP - extension with the Lenz PowerFlow® system**

- 2 headers
- 2 sport cam shafts
- a second Lambda sensor
- 2 sport metal catalysts with heater boxes
- final muffler with Lenz PowerFlow® integrated exhaust system

## 8. Results P – C - P

### □ Performance increase

The Lenz PowerKat® system for the 911 Carrera 2 / 4 clearly improves the response mode (throttle response), the performance and the accelerating power compared to the base engine. The dynamic optimization results from special algorithms in the controller software. Special emphasis was placed on performance increase in the widest possible rpm range.

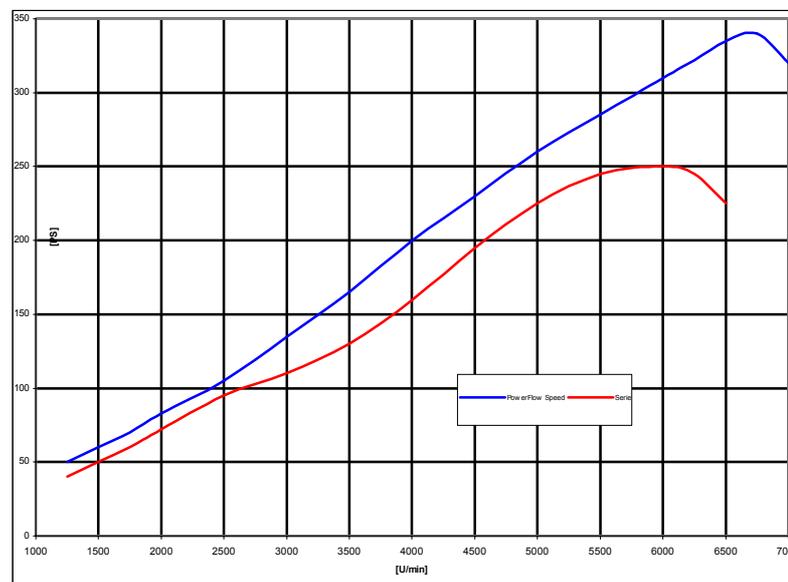
### □ Consumption optimization

The precise adherence to the ideal values for ignition degree and injection amount and the measurement of the operating condition over high-quality sensors results in a specific consumption particularly favorable in the comparison to the series engine. The Lambda regulation works over the entire load and rpm spectrum as a dynamically regulated system of high quality. Thus in mixed driving very favorable values consumed are obtained.

### □ Pollutant reduction

The Lenz PowerKat® system for the 911 Carrera 2 / 4 fulfils EC guideline 91/441 and is therefore classified as low-pollution equivalent to the Euro-standard I.

**Full load curves Lenz PowerKat in relation to series**



### Performance comparison

Version	HP	Torque	Top Speed
Series engine (factory specs)	250/260 HP	310 Nm	260 km/h
Lenz PowerKat®	310 HP	350 Nm	280 km/h
Lenz PowerFlow®	340 HP	365 Nm	290 km/h

## 9. TÜV - certification

The Lenz PowerKat system was certified by the TÜV Munich for the 911 Carrera 2/4. In the test report the performance and pollutant values, maximum speed and sound levels were documented. Thus an entry of the Lenz KatTronic ® into the registration papers is possible problem-free.

## 10. Installation, start up, maintenance and guarantee

A substantial advantage of the Lenz PowerKat ® system is the lack of mechanical interventions into the engine. The components can be installed by the manufacturer or in authorized workshops problem-free. If necessary the vehicle, at relatively small expenditure, can be returned back again to the original state. Under normal conditions the Lenz PowerKat ® system is maintenance-free. The special software necessary for the diagnosis and adjustment of the Lenz KatTronic ® engine management is only available from the manufacturer or in authorized workshops.

For the installation and initial set-up, the instructions in the installation and operating manual absolutely must be followed. Incorrect assembly of the components can cause malfunctions or damage, in this case the guarantee for the system components expires.

Basic condition for optimal functionality and fulfilment of performance data of the Lenz PowerKat ® system is naturally a mechanically intact, not worn engine, which was maintained according to the factory specifications. Only in this case can a guarantee for the indicated performance data be made. On the components of the system a 1 year warranty starting from the delivery date is made.

The price for the Lenz PowerKat ® system includes expressly only the components of the basic version and their assembly. Additionally necessary service work and the exchange of defective and/or worn components are charged for as incurred.

The technical data refer - if nothing different is mentioned - to the basic version of Lenz PowerKat ® system for the Porsche 911 Carrera 2/4.

Technical changes remain reserved for.

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