

Lenz PowerKat[®] System for Porsche 911 Carrera 1 / 3.2 Bj. 84-89



1. The Porsche 911 Carrera

Introduced in 1984 as the successor to the 911 SC and built until 1989, the Carrera 1 with a 3.2 liter engine and 231 PS had with the Bosch Motronic for the first time a modern engine management, which replaced the previously used mechanical Bosch K-Jetronic. Up to the development of the 3.6 liter engine with 250 PS, which was offered in 1989 first in the Carrera 4 and then starting from model year 1990 in the Carrera 2, the Carrera 1 engine was, apart from the turbo-models, the performance-related high point of the 911 series, which captivated by an inspiring performance, a relative thriftiness and a high mechanical reliability. As a result of increasingly intensified exhaust regulations in particular in the US market, as well as in the domestic German market, an engine version with a regulated 3-way-catalyst was offered starting in 1985, which developed first 207 PS with reduced compression of 9,5 : 1 and use with euro-super, later then 217 PS. As a consequence the factory also offered for the 10,3 : 1 compression 231-PS version a catalyst retrofit kit, by which the performance sinks to under 220 PS.

Both the factory installed catalyst version and the retrofit kit catalyst clearly reduced the performance development, the aggressive bite and the revving joy with increased *fuel consumption* in comparison to the non-catalyst version, with the result that the catalyst version was not well received ex factory on the European market and also the number of the conversions held itself so far within limits.

The environmental-politically-driven disadvantage of driving bans for non-catalyst vehicles during ozone alarms, permanent driving bans in ever more city centers, and drastically higher taxation since July 1997 as well as lower resale chances forces many vehicle owners to catalyst conversion.

Many Porsche drivers do not want to accept a performance loss resulting from a catalyst conversion if possible. The newly developed system Lenz PowerKat[®], is a solution which offers to connect optimized pollution emission with improved performance based on modern technology compared to the base engine of the Carrera

On the basis of the Lenz PowerKat[®] system additional components for increased output levels can be implemented.

2. The conception of the Lenz PowerKat[®] system

The Lenz PowerKat[®] system is conceived as an uncompromising high end catalyst retrofit system particularly for high performance engines. Developed on the basis of an *efficient* digital engine management, with components specially matched to the engine and using a metal catalyst, this system achieves optimal pollutant values with clearly improved engine performance. As pollutant standard, the guideline 91/441 (euro 1) is implemented at present, with which the retrofit vehicles are absolutely equivalent in comparison to the today's state of the art. By the classification as low-pollution, the Lenz PowerKat[®] retrofitted vehicles are excluded from the driving ban during ozone alarm (ozone plaque) and are taxed according to the Euro 1 - rates presently at 10.84 € / 100 cm³.

3. Technical implementation

Under the prerequisite that no mechanical interventions are to take place into the engine, the Carrera 1 engine offers essentially the following starting points for performance optimization:

- The restrictive air intake *flow* metering prevents a utilization of the full intake *diameter* and thus an optimal filling.
- The standard ceramic catalyst builds a high exhaust back-pressure with *restrictive* effect and efficiency loss in particular at higher rpms.
- The exhaust system has a flow technical relatively unfavorable *routing* of the individual exhaust *manifolds* with different distances through the heat exchanger.
- The series exhaust *shows* a high, progressively increasing exhaust back-pressure at higher revolutions additionally.

The substantial idea with the adaptation of the Lenz PowerKat[®] system for the Carrera exists in the systematic and consistent use of the above points for performance optimization in connection with a regulated metal catalyst. Principle item of the Lenz PowerKat[®] system is the digital engine management Lenz KatTronic[®] with which injection and ignition can be controlled extremely precisely. The standard Bosch Motronic controller is replaced by the plug and pin-compatible Lenz KatTronic[®] controller. The improved performance results from the more effective engine control, the enlargement of the effective intake *diameter*, from a resonance load effect in the intake manifold and by reduction of the exhaust back-pressure. New components such as an alpha/n air measurement system, a venturi tube and a metal catalyst are used.

4. Performance optimization

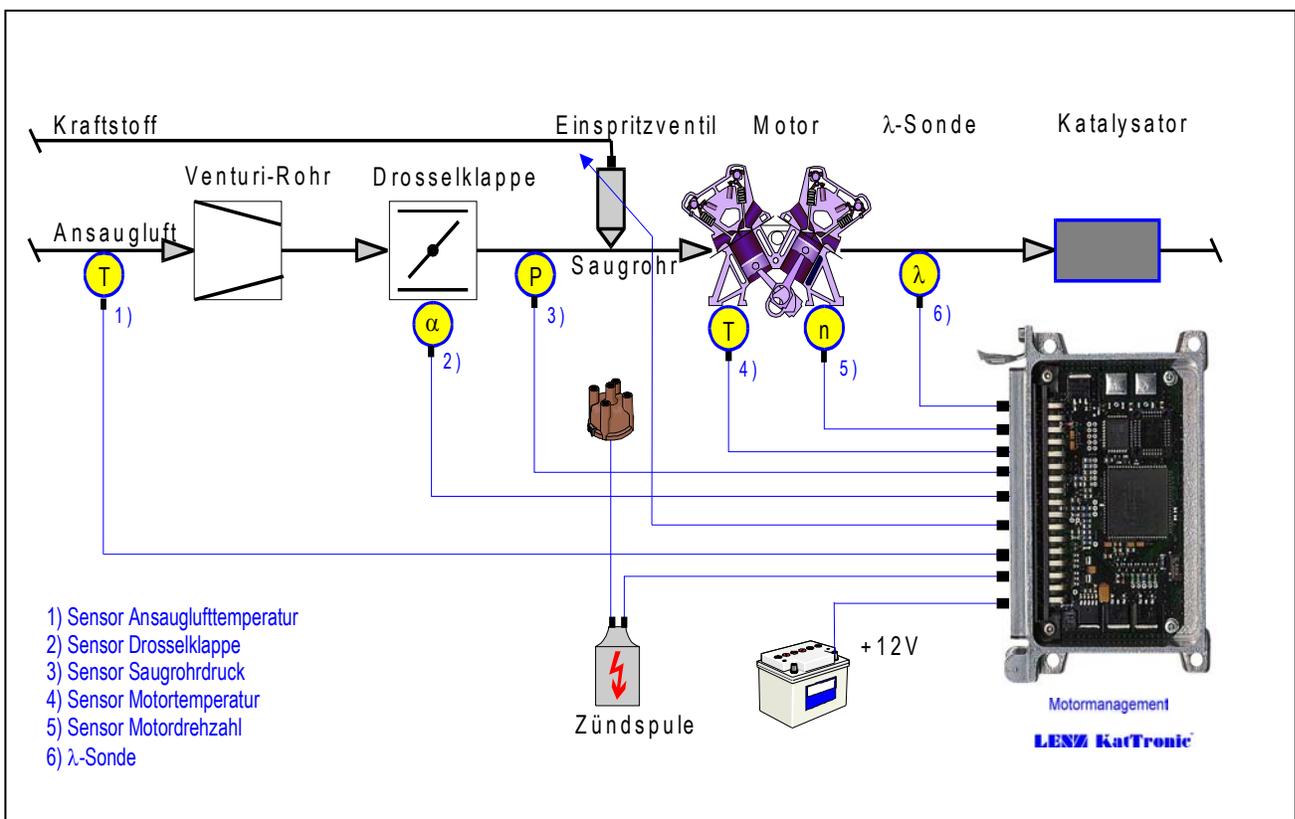
Only through the efficiency of modern engine controls can the constructionally given potential of a sport engine be effectively used. Base of the development is a careful analysis of the *vibration* response of the engine on the intake and the exhaust side. For this, extensive measurements on the Lenz engine test stand were performed. Thereupon the basic adjustment of the system components took place in stationary operation. The dynamic behavior of the engine was optimized in numerous measuring phases. From the analysis of data recorded while driving (data-recording) substantial information about improvement potentials in the dynamic behavior could be won, which were transferred to engine control on the software level. Experiences of many years in motor sport flowed into the development, which resulted altogether in an performance-optimized total system.

For the 911 Carrera 1 the system was in particular optimized regarding engine performance and accelerating power in the comparison to the non-catalyst base engine, so that the typical character of this vehicle is preserved also with catalyst.

5. System structure

The engine-specific adaptation of the Lenz KatTronic[®] to the injection system is effected through specially developed and adapted sensor/actuator components. For the precise measurement of the operating dimensions of the engine, high-quality, select sensors are used.

Adaptation Lenz KatTronic[®] for Porsche 911 Carrera 1



6. The engine management Lenz KatTronic[®]

The Lenz KatTronic[®] is a modern, modular structured digital engine management for injection and ignition with the Infineon Microcontroller C517A as CPU. The storage of the *data tables / maps* and control parameters takes place in flash memories. A special, hardware-supported signal processing enables the ultra fast and highly exact processing of the sensor data and a high system throughput. The system software operates real-time, i.e. calculates each injection and ignition phase up to the maximum permissible engine speed in real time from the sensor data and operating dimensions. The result is a delay-free adjustment of the engine control to the respective operating condition.

Special algorithms are implemented in the software management for the optimization of the dynamic behavior. The Lambda regulation operates according to a modified PID rule algorithm practically delay-free over the entire load/rpm spectrum, the reference is derived from a Lambda *data table / map* with additional specific corrections. The regulation operates adaptively, i.e. from the measured values of the Lambda sensors parameters are derived, which are stored in an adaptation *data table / map*. In long-term operation performance data are *maintained* by up-dating of engine electronics on a constant level. 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.

The development line of the Lenz KatTronic[®] is based on the Lenz TurboTronic[®], a complex, professional engine management system, which was used among other things successfully in formula 1 (BMW engine). From it the Lenz TurboTronicLight[®] (TTL) is derived, which was conceived as the more economical version of the Lenz TurboTronic[®] for a broader application in motor sport (DTM) and for the production

series applications. The Lenz KatTronic[®] is a current advancement of the TTL toward pollutant optimization for the application in production vehicles with catalyst.

TurboTronic[®], TurboTronicLight[®] and KatTronic[®] are developments of Lenz Motorentechnik and as brand names are legally protected.

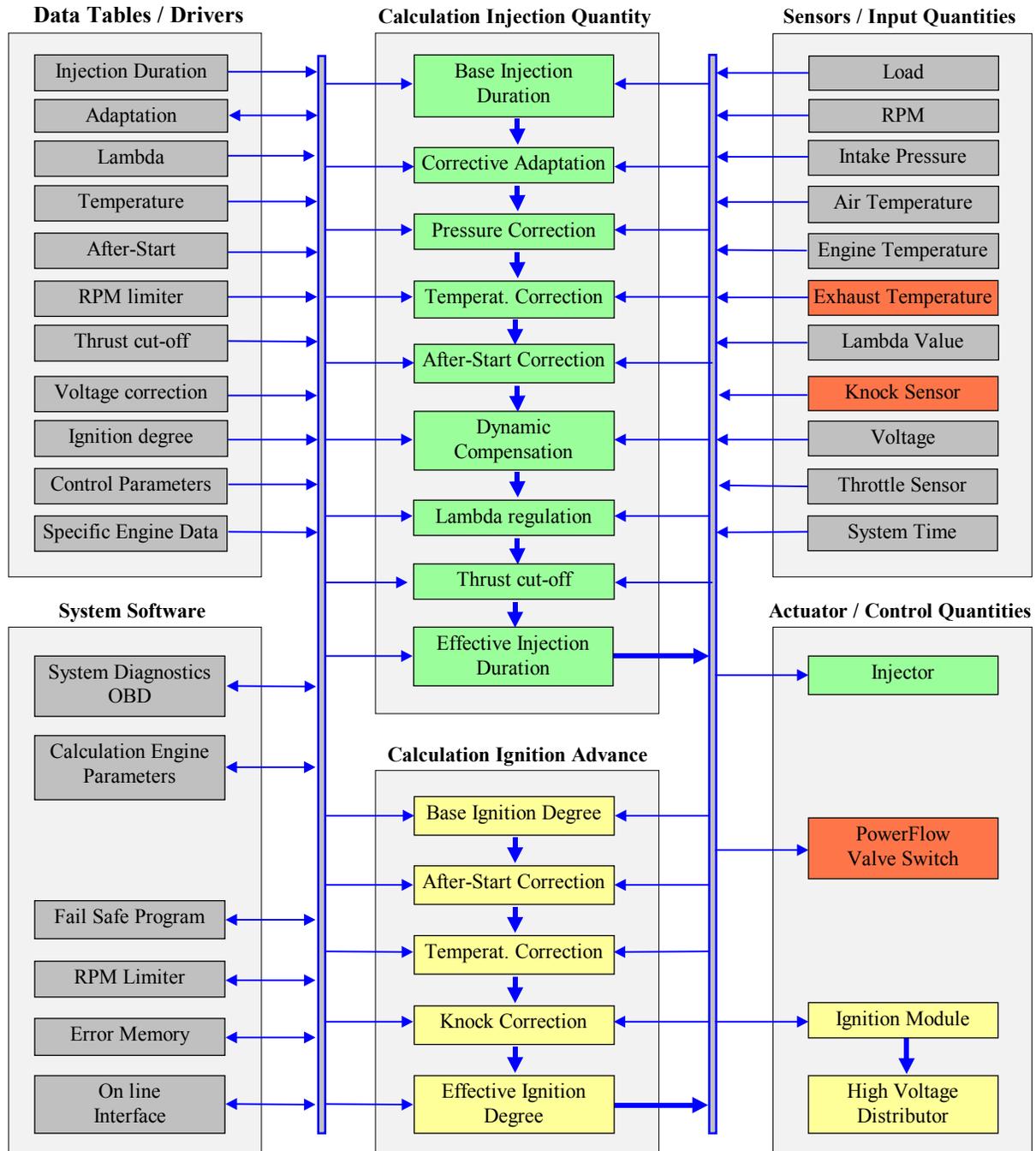
The Lenz KatTronic[®] Engine Management System



Picture of Controller

The engine management is plug and pin-compatible to the standard Bosch Motronic controller. The structure is executed in modern SMD technique 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

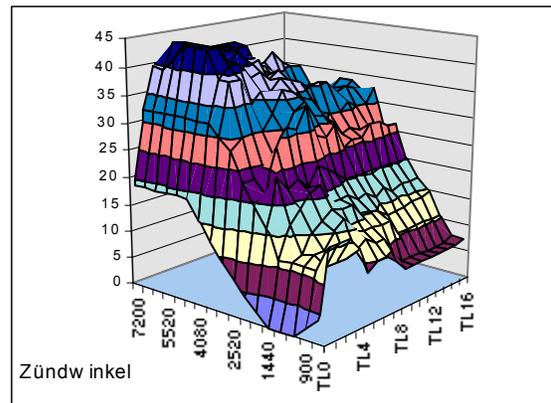
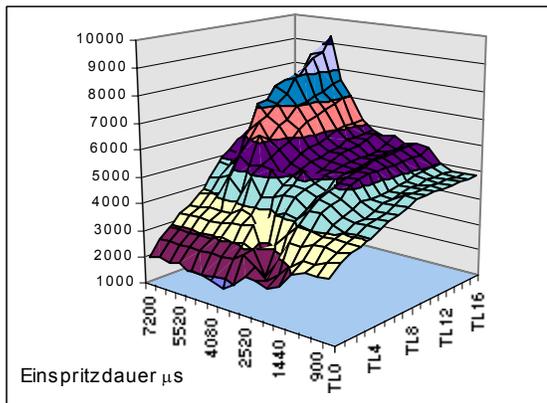
Base Functions

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)

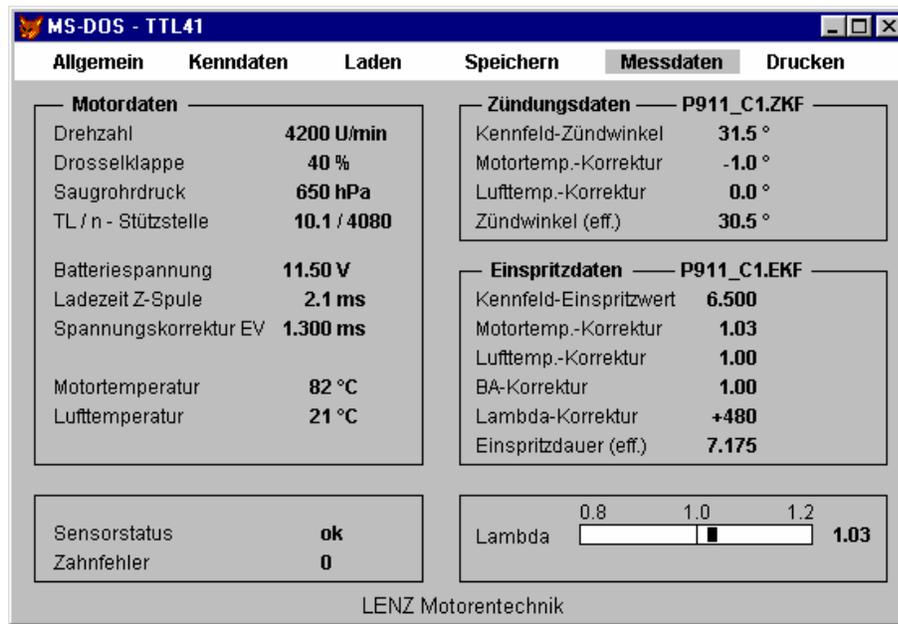
Data tables / Maps for injection duration and ignition degree



7. The software to the Lenz KatTronic®

A singular feature of the Lenz KatTronic® is the integrated serial interface to standard PC (operating system MSDOS) executable software. In the standard version important system data can be displayed on-line in current driving conditions on a graphic display (e.g. laptop with MSDOS) and diagnostic data for service purposes can 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 measuring data can be recorded (data recording). In the extended version all functions can be used also over radio data transmission (cell phone with GSM Card) from a stationary PC (telemetry). 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® is a future-safe investment.

View of Measurement Data Display



8. System Components

The Lenz PowerKat® system for the Carrera 1 in the base version consists of the following components

- Injectors
- Venturi tube
- **Lenz KatTronic®** Engine management
- Sport metal catalyst with heated Lambda sensor
- Alpha / n air measurement system (throttle butterfly potentiometer, pressure and temperature sensor)

System Components



9. Results P - C - P

Performance optimization

The Lenz PowerKat® system for the Carrera 1 clearly improves the response mode (throttle response), the performance and the accelerating power compared to the base engine, and this, in connection with a catalyst. The torque development is fuller in the entire rpm range, and the response is in particular substantially more pronounced at higher rpms than the series engine. The rpm limit is increased similar to the club sport special model.

As a performance related stage of development, the Lenz PowerFlow® system is optionally available. With this system it concerns a variable adjustable exhaust system, which uses specially coordinated resonance and flow characteristics and in particular minimizes the exhaust back pressure in the upper rpm range. In connection with a sport cam shaft a considerable performance increase is offered. Additionally the Lenz PowerFlow® system offers particularly attractive sound characteristics. The acoustic sound spectrum extends from reservedly quiet at idle and in partial load operation up to noticeably sporty at higher rpms and higher performance. As stages of development for the Lenz PowerKat® system the Lenz PowerFlow® exhaust system is offered in two versions:

Lenz PowerFlow® Light

- Sport exhaust with one outlet
- Integrated electro-pneumatic valve
- Software for Lenz KatTronic® controller

Lenz PowerFlow® Speed

- Sportcamshaft
- Header system
- Two metal catalysts with heater boxes
- Two integrated electro-pneumatic valves
- Software for Lenz KatTronic® controller
- Two lambda sensors with stereo lambda regulation

Version	Torque	Horsepower	Top Speed
Series engine without catalyst	284 Nm 5000 rpm	231 PS 5900 rpm	245 km/h
Series engine with catalyst	265 Nm 5000 rpm	217 PS 5900 rpm	240 km/h
Lenz PowerKat with series exhaust	290 Nm 5000 rpm	245 PS 6200 rpm	255 km/h
Lenz PowerKat with Lenz PowerFlow Light	305 Nm 5000 rpm	260 PS 6500 rpm	265 kmh
Lenz PowerKat with Lenz PowerFlow Speed	320 Nm 5500 rpm	280 PS 6800 rpm	275 kmh

- **Consumption optimization**

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

- **Pollutant optimization**

The Lenz PowerKat[®] system for the Carrera 1 fulfills the equivalent EC guideline 91/441 and is therefore classified as low-pollution according to Euro-standard I. Thus an engine equipped with the Lenz PowerKat[®] system does not fall under a driving ban during ozone alarm, and the ozone plaque can be issued for the vehicle.

10. TÜV certification

The Lenz PowerKat[®] system was certified by the TÜV Munich for the 911 Carrera 1. In the test report the performance and pollutant values, maximum speed and sound levels were documented. With the available TÜV certification, an entry of the Lenz KatTronic[®] into the title / registration papers is possible, problem-free.

11. Installation, set-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 engine control Lenz KatTronic[®] is available only 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.

If the vehicle was previously operated with leaded gasoline, then the tank as far as possible must be run dry and before installation, the vehicle absolutely must be driven with a full tank of unleaded fuel in order to exclude damage to the catalyst by lead. Relevant investigations by car manufacturers (Mercedes Benz) regarding lead free operation of engines with not-hardened valve seats conclusively show that as a result of prior long-term actual operating time with leaded gasoline sufficient lead diffuses into the valve seats (memory effect), so that no negative effects are to be expected on the life span of the valve seats. We recommend nevertheless the use of suitable lead replacement additives, which have proven innocuous for emission control systems (e.g. Castrol).

Basic condition for optimal functionality 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 Lenz PowerKat[®] system, a 1 year warranty starting from delivery date is made.

The price for the system Lenz PowerKat[®] includes expressly only the components of the catalyst retrofit kit and their assembly. Additionally necessary service work and the exchange of defective or worn components are charged for as incurred. The technical specification refers - if nothing different is mentioned - to the basic version of the Lenz PowerKat[®] system for the Porsche 911 Carrera 1.

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