

System Lenz PowerKat[®] for Ferrari Testarossa



1. The Ferrari Testarossa

In 1984 at the Paris auto show the newly presented Ferrari Testarossa received special praise: an attentive observer joked that, the Ferrari Testarossa needs no wings because it was a wing itself. This was the correct statement at a time, when the bad styling of wildly growing aerodynamics increasingly disfigured the beautiful proportions of many vehicles.

At almost two meters, nearly twice as wide as high, and a profile, which resembled the silhouette of a wing, the fivefold side air vents, which supplied the radiator with the necessary portion of fresh air, lent to this automotive creation of the Pininfarina branch, Studie Ricerche S.p.A. in Cambiano a special, characteristic attraction. Up to replacement by the follow-up version 512 TR produced since the 2nd half of 1991 and presented in January 1992, the Testarossa was rightfully a very popular and successful model. Including the successor 512 TR 9,463 were produced.

The 180° V engine with a displacement of 4,942 cm³, evenly distributed on 12 cylinders, was in principle carried over from the 512 BBi and achieved by means of four-valve technology 390 HP at 6,300 rpm. The maximum torque was with 500 Nm. As injection system the Bosch K/KE- Jetronic with two fuel pressure regulators was used for the two cylinder banks, the ignition was done by a Marelli Digiplex. While the predecessor model 512 BBi by introduction of the injection system K-Jetronic suffered a 20 HP power loss in relation to the carburetor model 512 BB, with the Testarossa, the theoretical performance advantage of fuel injection was realized. With the available performance potential, a top speed of 285 km/h could be achieved. The red painted cylinder head covers of the Testarossa obviously remind of the inheritance of Testa Rossa. The successor 512 TR was optimized in some points: 38 HP more performance, 40 kg of less vehicle weight and more efficient brakes documented the in the meantime obtained technical progress.

As a result of world-wide increasingly intensified exhaust regulations the catalyst also became an inevitable topic for the Ferrari Testarossa . As reaction to it Ferrari offered on the export markets a version with a regulated 3 way catalyst, which developed clearly lower performance. Due to conditions at the time of catalyst technology (ceramic monolith) and the performance limits of engine electronics, no better result was attainable. In this configuration, the fascinating engine character of this vehicle suffers greatly. In addition the catalyst configuration on the German market is not certified as low-pollutant and is not available as a retrofit.

The present development within the area of exhaust regulations with driving bans during ozone alarms and in the town center, drastically higher taxation and smaller resale chances, have strongly increased the interest in a technically high-quality catalyst retrofit for the Ferrari Testarossa. So far there was no retrofit regulated 3 way catalyst offered for the Ferrari Testarossa on the German market, with which this vehicle fulfills an exhaust standard equivalent to Euro 1, not to speak of a solution, which offers a clear increase in output in connection with regulated 3 way catalyst.

The newly developed Lenz PowerKat ® system carries exactly this out, particularly for demanding sport engines. On the basis of many years of know-how and most modern technology it is possible to connect, so far incompatible opposites of optimized pollutant levels and clearly improved performance. The engine is updated to today's conditions of the engine control technology by high performance digital engine management and metal catalysts. The system is recommended as an up to date, sensible and economical investment in value retention and improved pollutant levels while at the same time offering clearly increased driving fun.

With the Lenz PowerKat ® system the classical Testarossa has again the technological and performance-related connection to today's model generations, and this with environmentally friendly consumption and emission values. Our slogan "classic meets future" stands for this successful synthesis of a classic automobile with high tech.

2. The conception of the Lenz PowerKat® system

The Lenz PowerKat® system is conceived as an uncompromising high end system for catalyst retrofit with an increase in output. It was developed with the philosophy to retrofit the engine using most modern technology with improved performance and a regulated catalyst. The pollutant standard EEC guideline 91/441 is effective at present, with which the retrofitted vehicles are absolutely equivalent in comparison to today's conditions of the catalyst technology and are classified concerning the pollutant limit values equivalent to today's new vehicles according to Euro-standard I.

For the Ferrari 512BBi/Testarossa, the system was, in particular compared with the non-catalyst base engine regarding the criteria engine performance, torque development, specific consumption and acceleration capacity, optimized with the result that with catalyst the sporty engine character remains completely and the excellent performance is improved.

3. The technical realization

The Ferrari 512BBi/Testarossa uses the mechanical Bosch K/KE-Jetronic with two fuel pressure regulators for the two cylinder banks. The exhaust manifolds of the two cylinder banks are thermally insulated and equipped with two lambda probes, whose signals are separately processed (stereo lambda regulation). A high-quality sport metal catalyst is integrated in the existing muffler. Both the original muffler or modified mufflers can be used.

Principle item of the retrofit system is the digital engine management Lenz KatTronic®, with which injection and ignition can be controlled extremely precisely. Control of the injection amount necessary for lambda regulation is made by a pulse valve and/or the electro-hydraulic pressure plate in the pressure regulator of the Bosch K/KE Jetronic. The pressure plate permits an influence of the differential pressure over the turn slots and thus a variation in the quantity throughput of the continuously working injectors. The electrical control of the pressure plate takes place directly via the engine management that, as a function of the signal of the lambda probes, the engine load, number of rpms and the operating condition of the engine, computes the optimal injection amount over two separate data tables / maps. The sensor technology measures the values for temperature and pressure which are also considered. The ignition system of the Lenz KatTronic® system operates likewise, controlled by data tables / maps, the optimal ignition degree is computed as a function of number of rpms, load, intake manifold pressure and the operating condition. The ignition is made by high voltage distribution (distributor).

The Lenz PowerKat® system uses exclusively first-class technology from in house development using select components of well known manufacturers (Bosch, Siemens).

In addition to the base retrofit, fully electronic injection systems (intermittent injection) and ignition over *resting distribution* (of single ignition coils) are offered for high performance engines. In this case the load measurement is done with an alpha/n system with low-resistance, flow optimized air circulation on the intake side. As a maximum performance level, 2 turbochargers (KKK) with dynamic boost pressure control are offered.

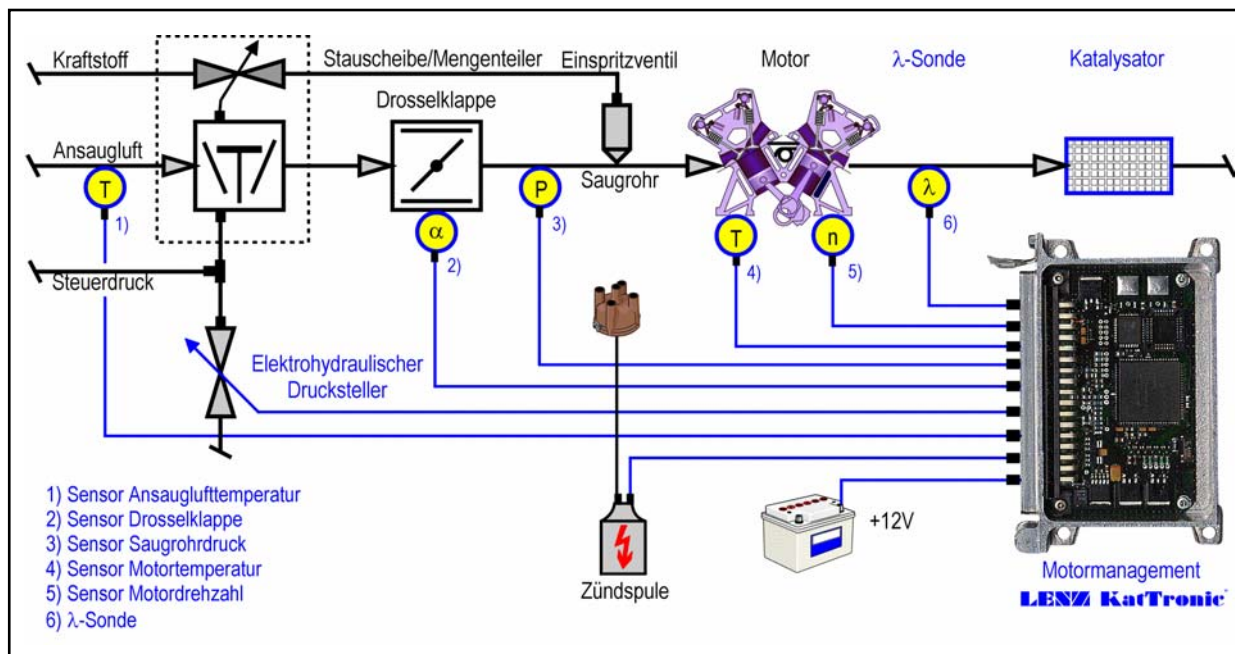
4. Performance optimization

Only by the efficiency of modern motor controls can the constructional potential of sport engines be effectively used. Principle item of the development for performance optimization is a careful analysis of the vibration response of the engine on the intake and exhaust side. For this, extensive measurements on the Lenz engine dynamometer were performed. The basic adjustment of the system components took place in the stationary operation. Intensive development and tuning work on the dynamometer resulted in newly determined data tables / maps for ignition and injection and in an improved specific performance yield. The dynamic driving behavior was optimized in numerous measuring runs. Years of experience in motor sport racing flowed into the tuning, which resulted altogether in a performance-optimized overall system.

5. System structure

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

LENZ KatTronic® for Bosch K/ KE-Jetronic



6. The Lenz KatTronic® engine management

The Lenz KatTronic® is a modern, modular developed 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 makes the ultra fast and highly exact processing of the sensor data and a high system throughput possible. 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 up dating of engine electronics. On board diagnostic routines permanently monitor the function of the sensor technology and store abnormal operating conditions as well as not implausible sensor data for diagnostic purposes. A fail-safe program permits driving in the event of an error. A temperature-dependent rpm limiter protects the engine during the warming-up phase against excessive wear from too high rpms

Das Motormanagement LENZ KatTronic[®]



Picture of Controller

The structure of the Lenz KatTronic[®] system is executed in modern SMD technology according to EMV guidelines.

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

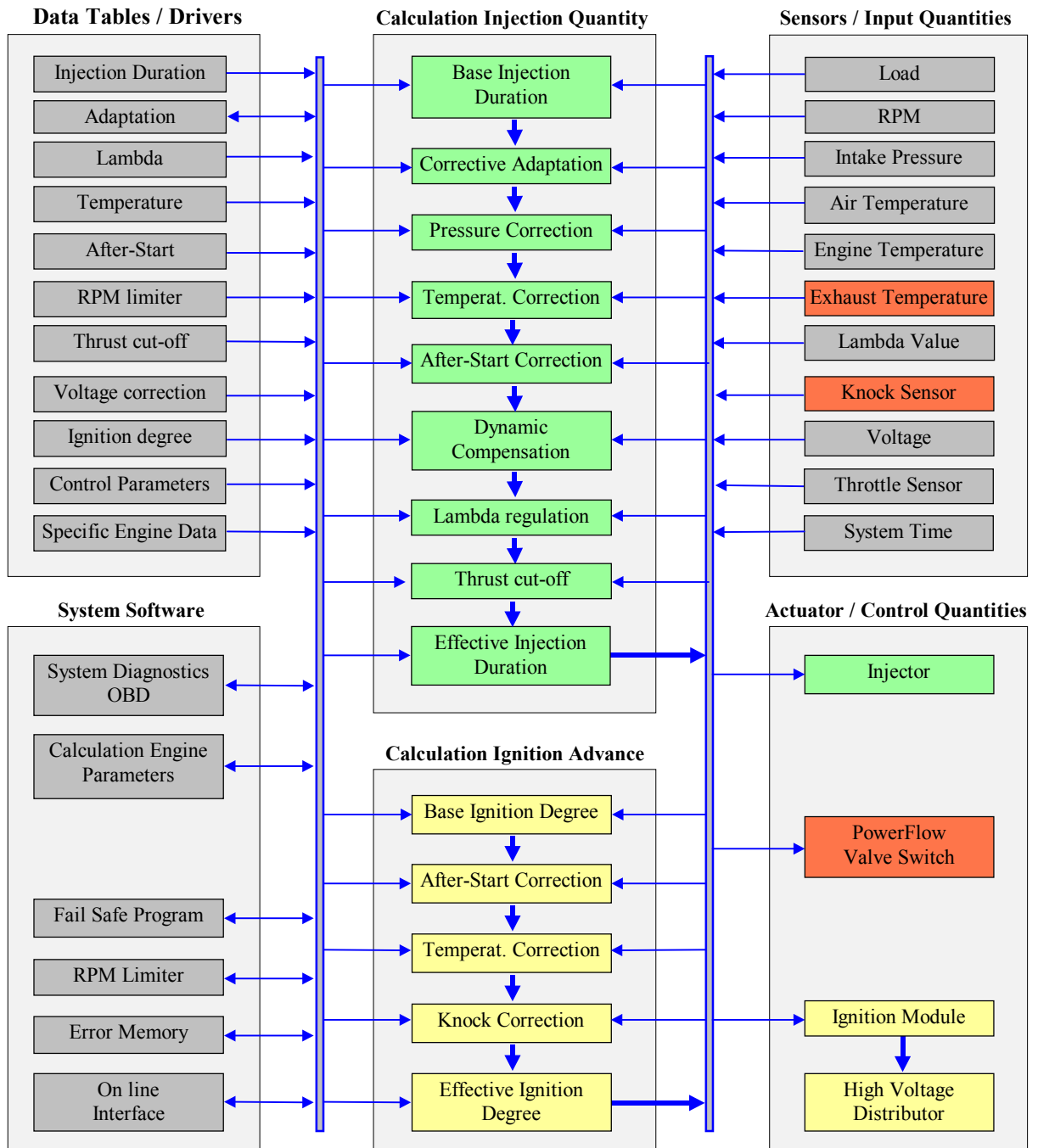
Base Functions

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

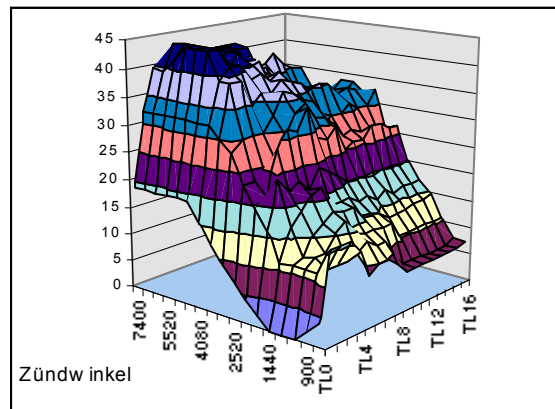
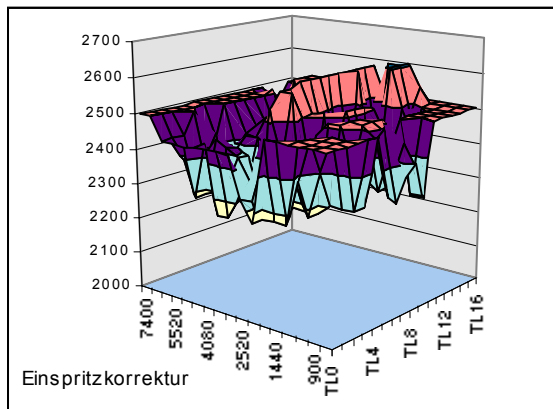
Monitoring Functions

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

Functional Structure of the Lenz Katronic® Engine Management System



Data tables / Maps for injection duration and ignition degree



7. The software for 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 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 / telemetry).

View of Measurement Display

MS-DOS - TTL41		TESTA.ZKF	
Allgemein	Kenndaten	Laden	Speichern
Motordaten		Zündungsdaten	
Drehzahl	4200 U/min	Kennfeld-Zündwinkel	31.5 °
Drosselklappe	40 %	Motortemp.korr.	-1.0 °
Saugrohrdruck	900 hPa	Lufttemp.korr.	0.0 °
TL / n - Stützstelle	10.1 / 4080	Zündwinkel (eff.)	30.5 °
Batteriespannung	11.50 V	Einspritzdaten — TESTA.EKF	
Ladezeit Z-Spule	2.1 ms	Kennfeld-Einspritzzeit	6.500 ms 6.700 ms
Spannungskorrektur EV	1.300 ms	Motortemp.-Korrektur	1.00
Motortemperatur	82 °C	Lufttemp.-Korrektur	1.03
Lufttemperatur	21 °C	BA-Korrektur	1.00
Abgastemperatur	495 °C	Lambda-Korrektur 1/2	+0.480 ms -0.325 ms
Sensorstatus	ok	Einspritzzeit (eff.) 1/2	7.175 ms 6.576 ms
Zahnfehler	0	Lambda 1	1.03
		Lambda 2	0.98

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

8. System components

The Lenz PowerKat® system for the Ferrari Testarossa consists in the basic version of the following components:

- wiring loom
- 2 lambda sensors
- **Lenz KatTronic®** engine management
- pressure and temperature sensors (alpha/n air measurement system)
- insulated exhaust manifolds to the muffler
- metal catalyst (to be installed in the muffler)

For the construction of high performance engines, additional system components are required. These depend on the individual specification (all-electronic injection, turbocharger)

9. Results P - C - P

☐ Performance optimization

The Lenz KatTronic®. for the Ferrari Testarossa 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 dynamic optimization results from special algorithms in the controller software. The values of the torque curve are up to 10% higher than the series engine over almost the entire rpm range, the maximum performance increases to 420 HP. The cut-off of the rpm limiter is adjusted to 7,000 rpm, so that the higher top speed higher can take advantage of the increased output. The maximum speed is with 300 km/h.

☐ 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 results in a specific consumption particularly favorable in the comparison to the series engine. The lambda regulation works over entire load and rpm spectrum as a dynamically regulated system of high quality. Thus in mixed driving favorable values consumed are obtained

☐ Pollutant optimization

With the Lenz KatTronic® system, the Ferrari Testarossa fulfills EC guideline 91/441 and is therefore classified as low-pollution equivalent to the Euro-standard I. Thus a Ferrari equipped with the Lenz PowerKat® system does not fall under a driving ban during an 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 Ferrari Testarossa. 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.

11. Reference

The conception of the Lenz KatTronic® is the result of a know-how potential, which was won in 30 years of experience in the engine electronics sector and motor sport. Developmentally the Lenz KatTronic® comes from the professional Lenz TurboTronic® and Lenz TurboTronicLight® (TTL) systems. Both systems have been successfully used for many years on most diverse vehicles in amateur and professional motor sports, Lenz TurboTronic® among other things in formula 1 - vehicles. Lenz KatTronic® is technologically specifically designed for the performance and pollutant optimization of series sport engines.

Lenz TurboTronic®, Lenz TurboTronicLight® and Lenz KatTronic® are in house developments of the company Lenz Motorentechnik and are legally protected as trademarks

12. 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 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 specifications refer - if nothing different is mentioned - to the basic version of the Lenz PowerKat - system for the Ferrari Testarossa with Bosch KE-Jetronic fuel injection.

The system is also available for the previous model 512 BBi with Bosch K-Jetronic. The Ferrari 512 with carburetion can, after conversion to electronic fuel injection, also be equipped with the Lenz KatTronic ® using a regulated catalytic converter. More information is available on request.

As an option, the innovative, actively controlled Lenz PowerFlow ® system is available, with a variable exhaust sound and improved performance and torque development over the entire rpm range. Additional information is available on request.

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