System Description for the BMW E30 – M3 Yr. 85 - 91

1. The BMW M3

The history of the M3 begins with an impressive name. It was the M1, that legendary, purebred sports car with mid engine, whose conceptual genealogy is found in all models of BMW Motorsport GmbH. The M3 expresses this most openly and honestly: It is conceived as an uncompromising high performance sports car. Developed and built, in order to win.

In the civilian version of the M3 there are championship qualities, the exemplary reliability and the readiness to perform of a series winner perfectly united with the requirements of a street car.

The strength of the appearance, the distinctive character, the inner values: every moment the responsible, sovereign driver of an M3 feels the true identity of his automobile.

The most spectacular testing of a BMW M3 engine is preferably Sundays: the race tracks worldwide. Here BMW demonstrates its authority in construction of high speed automobiles and engines publicly and successfully.

Both the factory installed catalyst version and the retrofit 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 retrofits was limited.

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 the catalyst retrofit.

Many BMW M3 drivers do not want to accept a performance loss resulting from a catalyst retrofit if possible. The newly-developed Lenz PowerKat ® system offers with modern technology a solution for the M3 which connects optimized pollutant behavior and improved performance in comparison to the base engine.

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 (key nr. 77 = euro 1) is effective at present, with which the retrofit vehicles are absolutely equivalent in comparison to today's state of the art

3. The technical implementation

Under the prerequisite that no mechanical interventions are to take place into the engine, the BMW M3 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 high exhaust back-pressure with restrictive effect and efficiency loss in particular at higher rpms.
- The exhaust system has flow technical relatively unfavorable routing of the individual exhaust manifolds with different lengths.
- The series exhaust shows a high, progressively increasing exhaust back-pressure at higher rpms additionally.

The substantial idea with the adaptation of the Lenz of PowerKat ® system for the BMW M3 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 connector and pin-compatible Lenz KatTronic ® controller. The improved performance results from the more effective engine control, the increase in 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

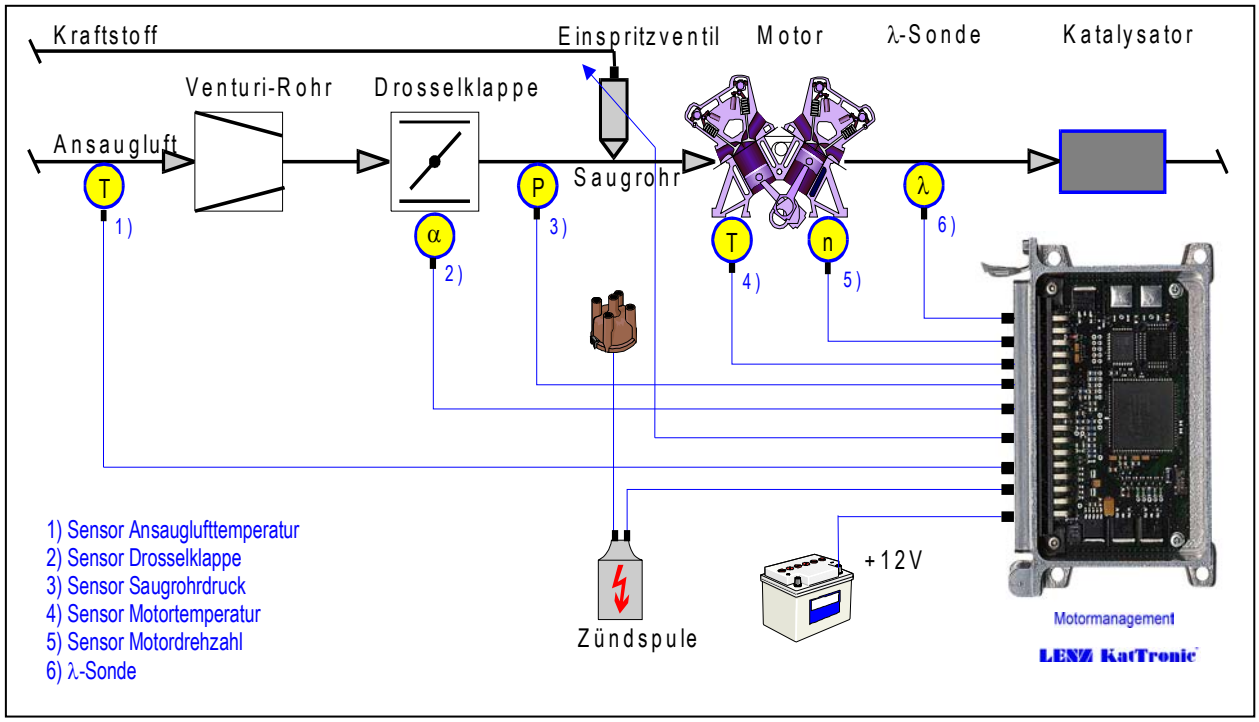
Only through the efficiency of modern engine controls can the constructional potential of a sport engine be effectively used. Base of the development is a careful analysis of the vibration response of the engine on the intake and the exhaust side. For this, extensive measurements on the Lenz engine dynamometer 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 runs. 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 a performance-optimized total system.

For the BMW M3 the system was in particular optimized regarding throttle response, engine performance and accelerating power in comparison to the non-catalyst base engine concerning response mode, so that the typical character of this vehicle remains also with a catalyst.

5. System structure

The engine-specific adaptation of the Lenz KatTronic ® to the injection system of the M3 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.

Adaption Lenz KatTronic® to BMW M3



6. The engine management

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.

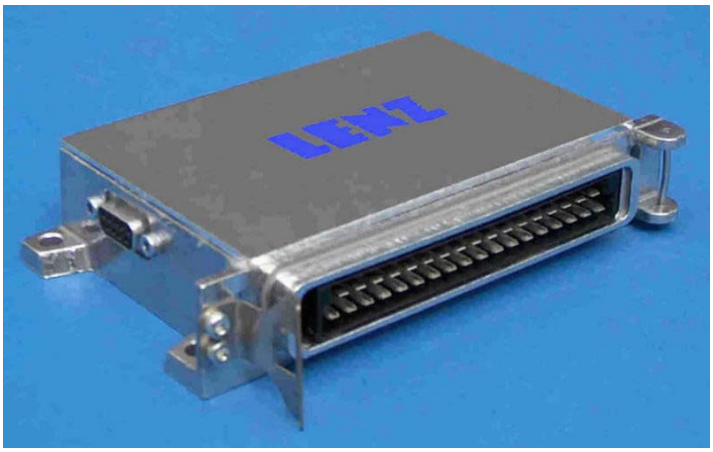
Special algorithms are implemented in the software management for the optimization of the dynamic behavior. The lambda regulation operates according to a modified PID rule algorithm practically delay-free over the entire load/rpm spectrum, the reference is derived from a lambda data table / map with 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 Motoren-technik and as trademarks are legally protected.

The Lenz KatTronic ® Engine Management System

Picture of Controller



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

Output Values
Injection
Ignition
Fuel Pump
Boost Regulation
Idle

Data Tables / Maps
Injection
Ignition degree
Lambda value
Lambda regulation
Load evaluation
Adaptation

Data Table Drivers
lambda Sensor
Engine Temperature
Air Temperature
Warm Up
Start Quantity
After-Start Faktor
Voltage Correction

Base Functions
Warm Up
Idle Regulation

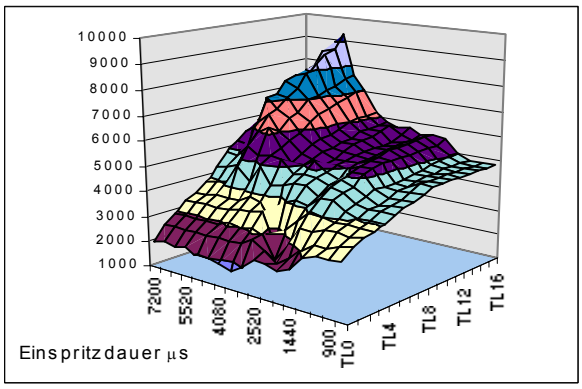
Temperature Compensation
Dynamic Transition Compensation

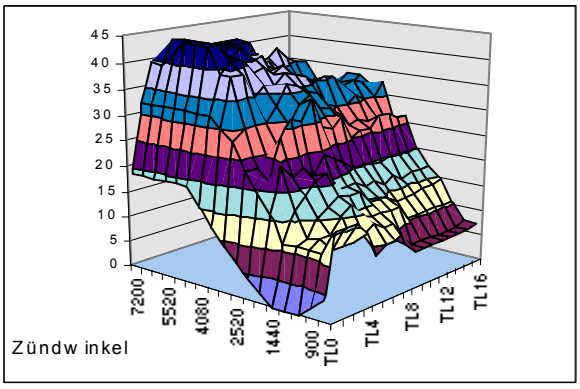
Asymmetrical PID lambda Regulation

Temperature Dependent Thrust reduction

Monitoring Functions
Error Memory
Fail-safe Program
Exteme value Memory
Sensor monitoring
Operating hour counter
Serial Interface (RS-232)
Temperature dependent speed limiter

Data tables / Maps for injection duration and ignition degree



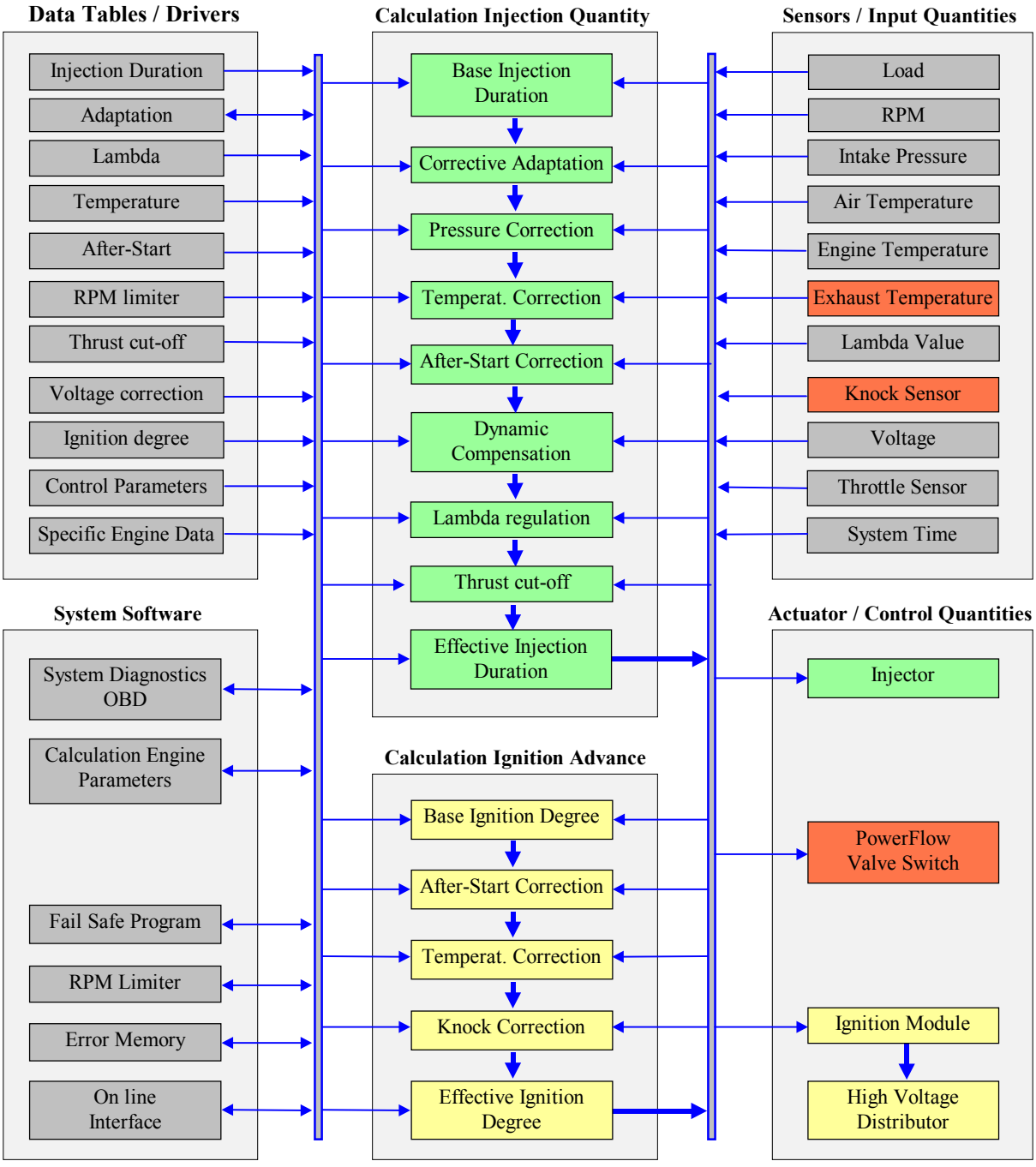


7. The Software for the Lenz KatTronic®

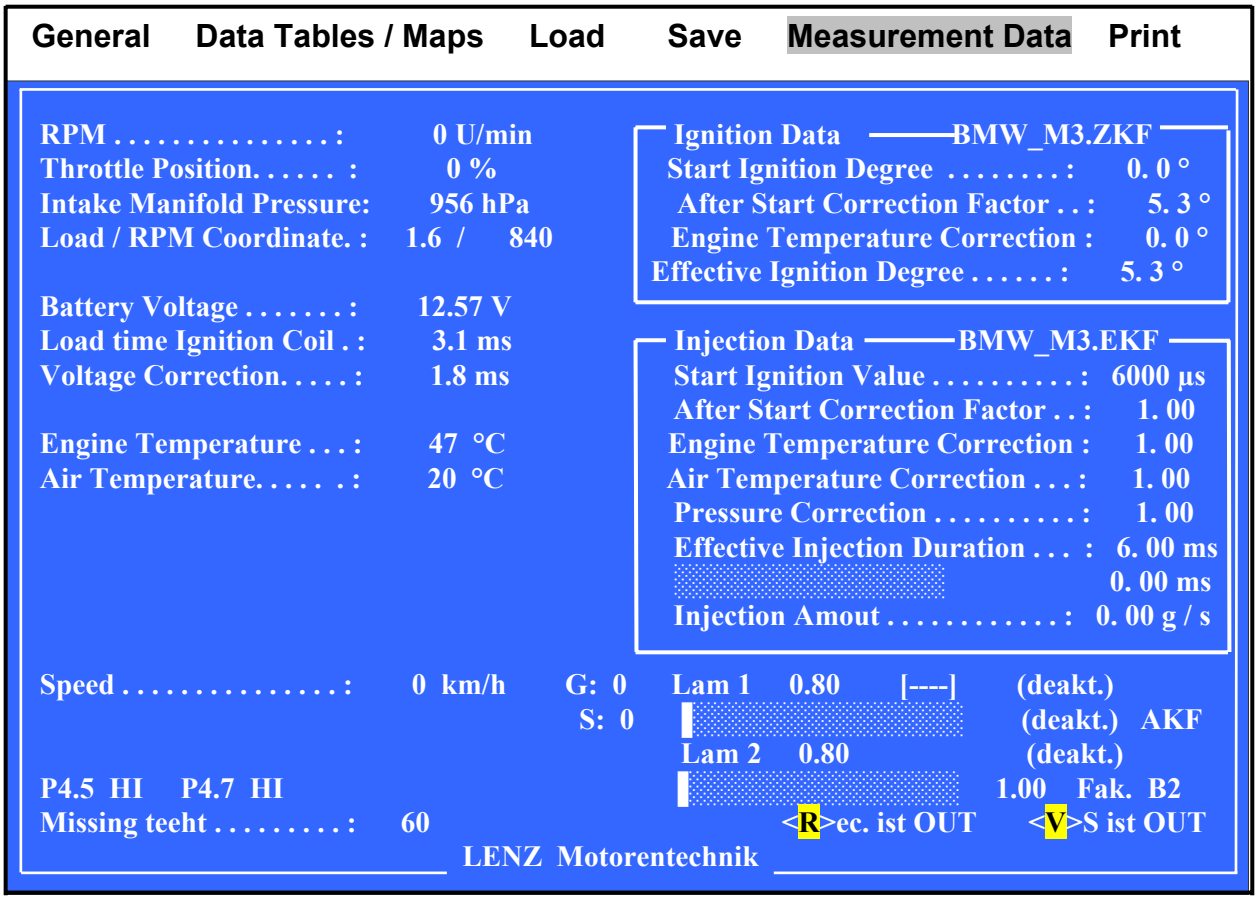
A singular feature of the Lenz KatTronic ® is the integrated serial interface to standard PC (operating system MSDOS) executable software. In the standard version important system data can be displayed on-line in current driving conditions on a graphic display (e.g. laptop with MSDOS) and diagnostic data for service purposes 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.

Functional Structure of the Lenz Katronic® Engine Management System



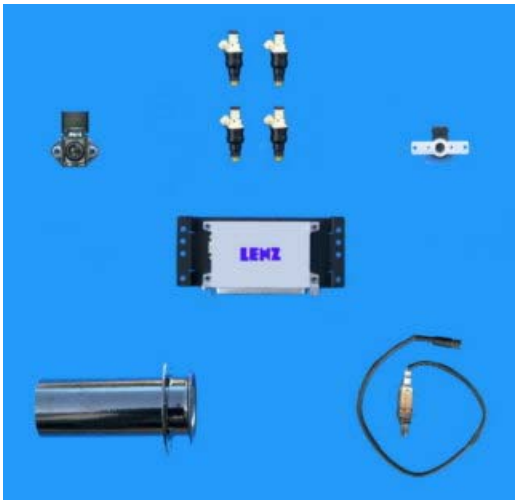
View of Measurement Data Display



8. System Components

The Lenz PowerKat ® system for the BMW M3 model consists of the following components in the base version:

- 4 injectors
- Venturi tube
- Throttle position switch
- Heated lambda sensor
- Pressure and temperature sensor
- Alpha / n air measurement system
- **Lenz KatTronic ®** engine management



9. Resalts P – C - P

❒ Performance increase

The Lenz PowerKat ® system for the BMW M3 clearly improves the response mode (throttle response), the performance and accelerating power compared to the base engine, and this, in connection with a catalyst. The torque development through the entire rpm range is fuller, and the response especially at higher rpms is significantly more pronounced than the series engine. The rpm limit is increased to the club sport level.

The Lenz PowerFlow ® system is available as an optional stage of increased performance. 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 camshaft a considerable performance increase is offered. Additionally the Lenz PowerFlow ® system offers particularly attractive sound qualities: the sound spectrum ranges from reservedly quiet at idle and partial load to noticeably sporty at higher rpms and higher performance.

❒ 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

With the Lenz KatTronic ® system, the BMW M3 fulfills the EC guideline 91/441 and is therefore classified as low-pollution equivalent 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.

The Lenz PowerFlow ® system is available as an optional stage of increased performance for the Lenz PowerKat ® system

Lenz PowerFlow® System

- **Sport camshafts**
- **Sport exhaust with two outlets**
- **Software for the Lenz KatTronic ® controller**
- **2 integrated electro-pneumatic valves**
- **2 metal catalysts and heat shielding**

10. TÜV certification

The Lenz PowerKat ® system was certified by the TÜV Munich for the BMW M3. 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.

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 BMW M3.

Technical changes remain reserved. **Dez 2002**

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