the automatioc recognition and detection of the wheels mounted to the vehicle. For this purpose, the electronic system of every wheel sends an individual, unmistakeable signal. By means of statistical evaluation of the incoming information, the system recognizes which types of electronic systems have been installed in the indivual vehicle (independent wheel recognition), and their installation position (assignment of positions).

During the independent wheel recognition, the vehicle's own wheels are identified. The telegrams received from the electronic system of every wheel are counted. If specific statistical preconditions have been complied with, this electronic system is recognized as an own wheel.

The assignment of positions of an electronic wheel system is carried out by means of a statistical evaluation of the intensity received on the individual antennas in the wheel houses. If the assignment has been determined unmistakeably, the positions are stored in a non-volatile storage unit.

When the ignition is turned on the next time, the process will start in the former order. If a new wheel has been mounted, the system has to re-teach its wheels and to determine the mounting positions again. As soon as specific statistical conditions have been fullfilled, the originally installed wheel is removed from the list of own wheels (taught off) and then the newly installed wheel is included into the list of the own wheels. The control is carried out only during driving to avoid influences on the stationary car from closely parked vehicles with tire pressure monitoring systems.

2.5 Control functions during standstill

After the ignition has been turned off, the control unit is switched to an economy mode. The control unit is then activated a short time before the expected regular data telegrams of its wheels. When the unit has received these telegrams, the control unit returns to economy mode.

Thus, the following functions can be realized:

- Warning in time in the case of a puncture before starting: A normal evaluation of the measured pressure value will be carried out when the ignition is turned on, and a respective warning is given, if required.

- Optionally, the tire pressure control system can be combined with a warning equipment which will be activated if somebody tries to damage the tire.

3. System Components

The tire pressure control system consists of the following components:

- 4 or 5 aluminium valves
- 4 or 5 electronic units in the wheels (sensor and high-frequency sending unit)
- 4 or 5 receiving antennas
- a special connecting cable appropriate for high-frequency transmission, between the receiving antennas and the control unit
- a control unit (high-frequency receiver and evaluation system)

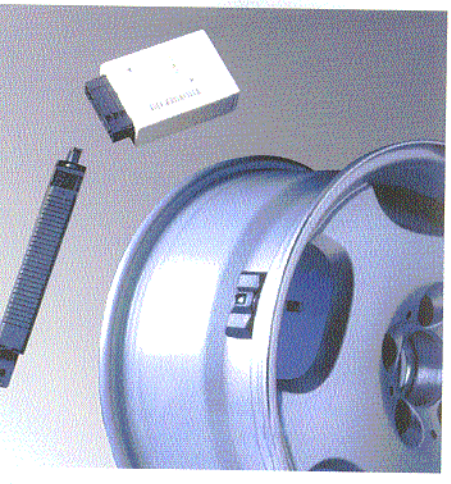
- **option:** keying device for entering a default pressure

At present, an individual output unit is not available, since the output of the messages to the driver is done via the driver information system belonging to the standard equipment.

3.1 Electronic wheel system

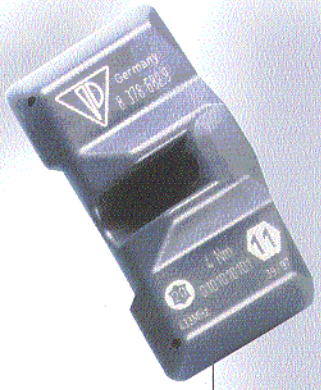
The battery-based electronic wheel systems are mounted inside the tires to measure the tire pressure and the temperature of the electronic wheel systems. Every electronic wheel system has an individual code (ID), which is transmitted with every message. Furthermore, the data telegram includes information about the remaining service life of the battery.

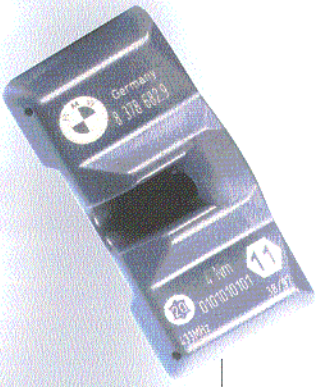
The measured data are transmitted from the wheel through a transmission point.
A tire pressure monitoring system has to carry out two main functions: The recognition of a pressure loss and the measurement of the absolute pressure. For the measurement of the absolute pressure, a relatively low frequency of measurement data transmissions is sufficient, a pressure loss must be transmitted immediately. The electronic wheel system shifts automatically to the various operating modi in order to carry out these functions at a minimum power consumption. Normally, every electronic wheel system measures the tire pressure and the approximate temperature of the air in the tire every three seconds but if the measured values are stable, sending processes are carried out only every 54 seconds. At a pressure loss of more than 0.2 bar per minute, the electronic wheel system shifts to a high transmission frequency. It will then carry out measurements and sending processes every 0.8 seconds. This energy management allows battery-based operation with a sufficient service life.



Components of the tire pressure monitoring system (DAIMLER-BENZ)

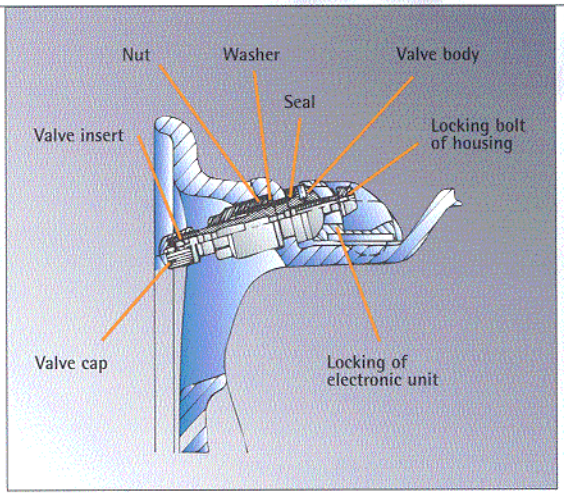
Features of the Valve
Low weight (aluminium)
Special coating with low surface friction and high corrosion resistance
Excellent resistance to chemical substances
Universal applicability for various rims and valve hole types
Easy mounting of the nut to avoid damage to the rim
Aluminium-colored plastic valve cap with seal





Genuine electronic wheel systems of the members of the workgroup tire pressure control

Features of the Housing
Spherical segment with slotted hole for the setting to various rim sizes
Rounded outlines without attachment points for mounting machines and tire bead
Three-point support for an optimum transmission of the mounting forces
Very good force absorption and transmission to the support points for protection of the electronic system from exterior influences
Plastic material with optimum mechanical, thermal and electromagnetic properties



Drawing of the valve with quotation of its special features

The electronic wheel system is combined with the aluminium valve to form a compact unit which is bolted to the standardized valve bore of the rim.
Its design allows mounting in almost every known rim type. The electronic wheel system includes an intelligent integrated sensor which is mounted on a circuit carrier and has been developed especially for this application. In its SMD housing, the two-chip intgrated sensor contains a pressure sensor element and an ASIC (Application Specific Integrated Circuit) with temperature sensor, measurement acquisition unit and a signal conditioning unit. This sensor directly controls a high-frequency sending unit. The power supply to the sensor and the sending unit is done by an environmental friendly lithium battery which has been developed especially for the high demands on temperature resistance, acceleration resistance and service life. In combination with the tire monitoring control unit, the typical service life is 7 years.
Due to the kinds of construction and connection technologies, the electronic wheel system is able to sustain the extreme conditions for a service period of about 7 years with the following features:

- Temperatures from -40 °C to +170 °C
- Extreme dynamic acceleration up to 2000 g
- Insulated against extreme humidity
- Resistant to all solid and liquid substances in the tire zone (mounting agent residues)

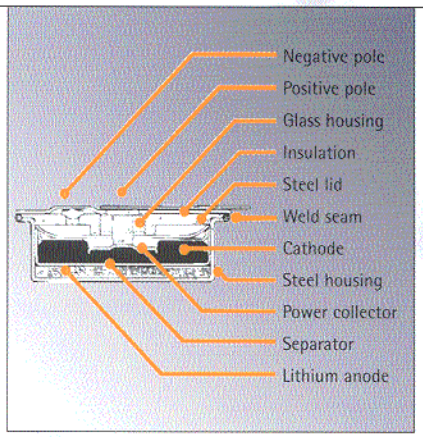
3.2 High Frequency transmission

The applied technique is a unidirectional high-frequency transmission of the measuring data from the wheel to the vehicle. The high-frequency transmission is carried out in the 433-MHz-range, the so-called ISM band or, in several countries, in the 315 MHz range. The system has been given approval by the telecommunication authorities of the relevant countries.
The data sent by the electronic wheel system are received by the antennas mounted in the wheels and are transmitted to the control unit by screened twisted pair cables.
Due to the design of the high-frequency transmission, the data telegrams can be received reliably even if influences of the most different kinds occur. Such influences are, e.g., statistical irregulations of the receiver amplitude due to varying receiving conditions in the wheel compartment caused by the wheel rotation and wheel position.

3.3 Control Device

The control device consists of a high-frequency receiving module, a control device plate with micro-processor control and the bus and diagnosis interfaces. It evaluates the received data and transmits the information to the driver information system. It is installed in a standard series housing.

Environmental friendly lithium battery



Environmental friendly lithium battery with typical discharge curve during application in a tire pressure monitoring system