07.4–0030 Design and function

A. General

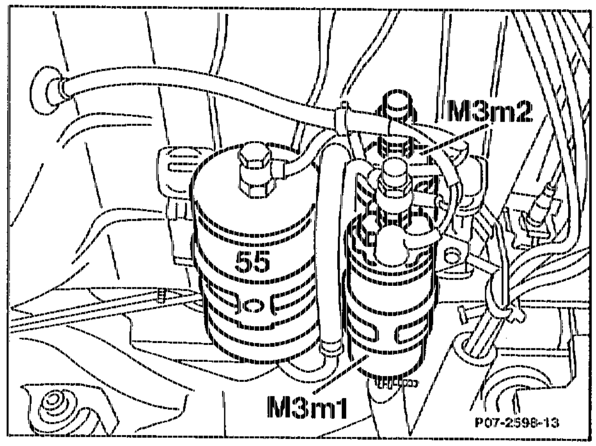
The engines are equipped with an electronic gasoline injection system with air mass metering by means of hot wire (LH) in order to be able to more accurately control fuel metering in all operating states of the engine.

The abbreviated designation LH means
L = air mass metering
H = hot wire

The basic system of the LH electronic gasoline injection system is a driveless, electronically controlled gasoline injection system.
The air mass inducted is measured directly by means of the hot wire air mass sensor.

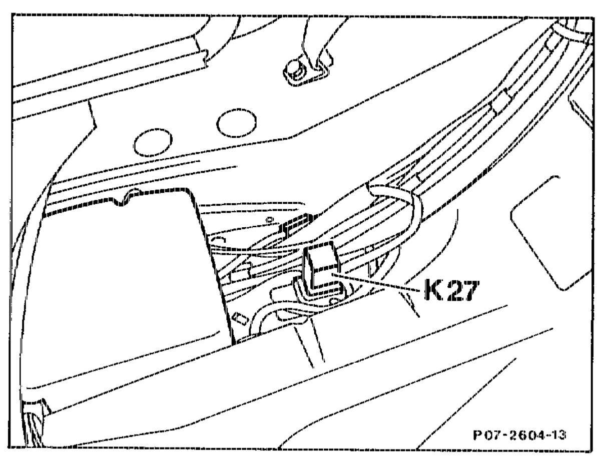
B. Fuel supply

a) Fuel pump set
Two fuel pumps (M3m1, M3m2), which are connected in series at the fuel side, pump the fuel from the fuel tank through a fuel filter into a distributor pipe. They are actuated during starting and so long as the engine is running. For safety reasons, they are only actuated for about 1 second in the ignition "ON" position (full running-safeguard).



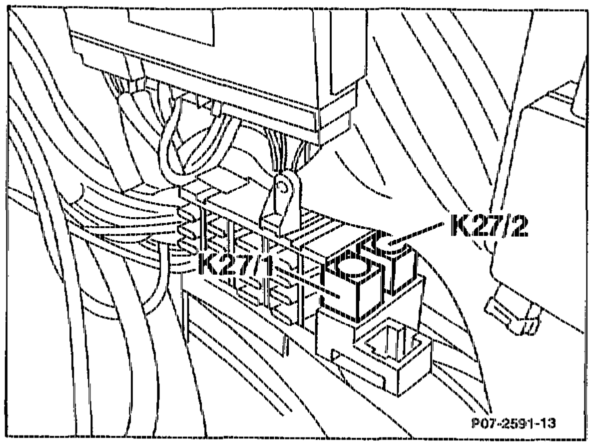
b) Actuation of fuel pumps

Engines 104, 119
They are actuated by the LH control unit (N3/1, section E) via the fuel pump relay (K27). Engine speed recognition for the control unit (LH) is achieved by means of the TN signal or, if the TN signal is not detected, by means of the camshaft position sensor signal.



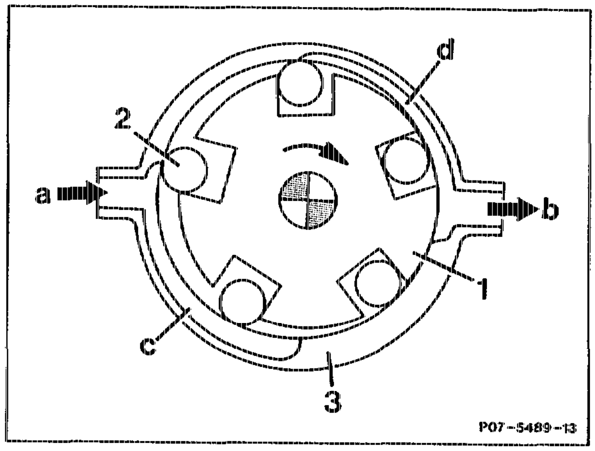
Engine 120

Both fuel pumps are actuated in parallel by the respective fuel pump relay (K27/1, K27/2) by both LH control units (N3/2, N3/3, section E).



c) Function of fuel pumps

The fuel pump is a roller cell pump and consists of a fuel pump housing with rotor ring (3), rotor disc (1) and the rollers (2). As a result of the eccentric arrangement of the rotor disc (1) to the rotor ring (3), a volume change occurs between the rollers during each revolution, as a result of which the suction and pressure effect of the pump is achieved. The rollers are pushed to the outside by the centrifugal force and act as a seal.

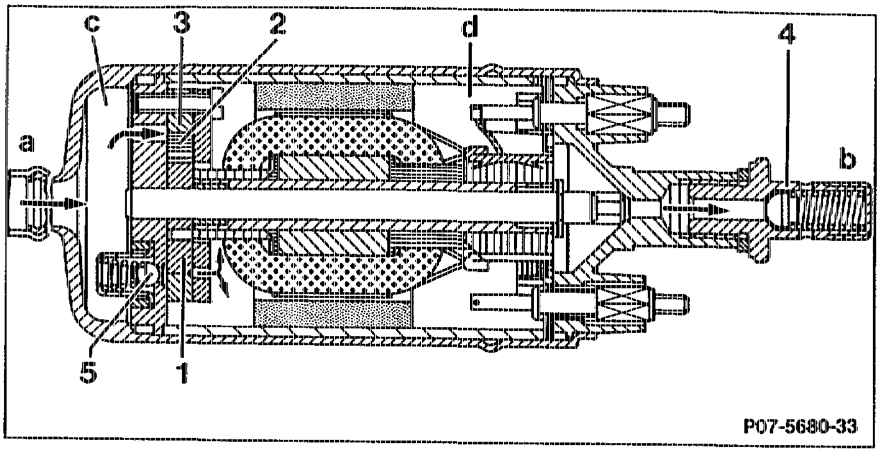


1 Rotor disc
2 Roller
3 Fuel pump housing with rotor ring

a Suction side
b Pressure side
c Fuel pressureless
d Fuel pressurized

1 Rotor disc
2 Roller
3 Fuel pump housing with rotor ring
4 Non-return valve
5 Pressure relief valve

a Suction side
b Pressure side
c Fuel pressureless
d Fuel pressurized



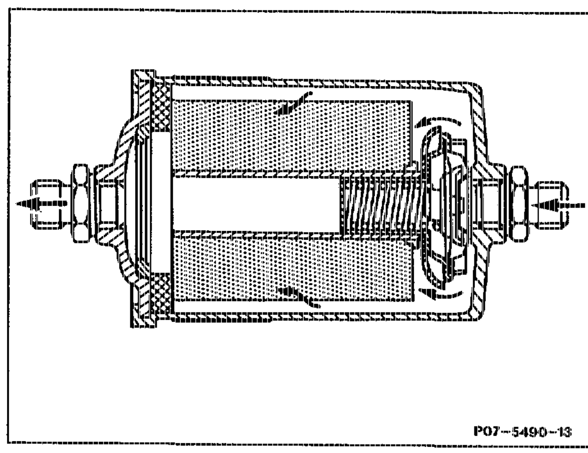
With a delivery of at least 90 l/h at 11.5 V (current consumption 6–10 A) the fuel pump supplies more fuel than the engine needs, as a result of which the engine is always supplied with cool fuel. The excess fuel flows back into the tank.

If the pressure rises to more than approx. 8 bar (e. g. because of constrictions in the fuel feed or return line), a pressure relief valve opens and connects the suction and pressure side within the fuel pump, as a result of which a further pressure rise is prevented.

When the engine is switched off, a reduction in the residual pressure through the fuel pump is prevented, among other things, by a non-return valve. This prevents the formation of vapour bubbles in the fuel injection system and improves warm starting characteristics. The non-return valve is fitted in the screw union and can be replaced separately.

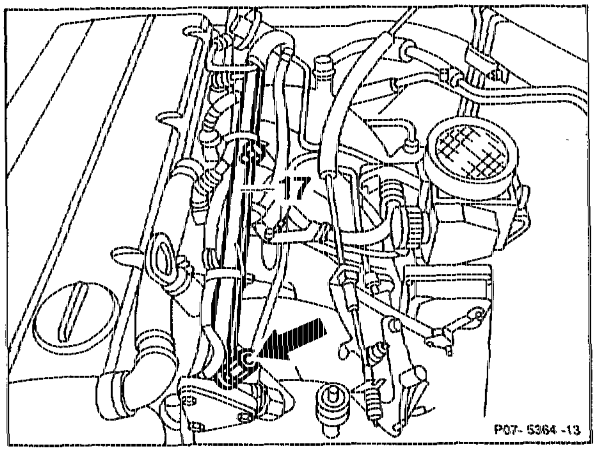
d) Fuel filter

The fuel filter is a fine filter with paper element. A damper is installed on the fuel feed side to avoid fuel noises. The fuel flow direction is indicated by an arrow on the fuel filter housing.

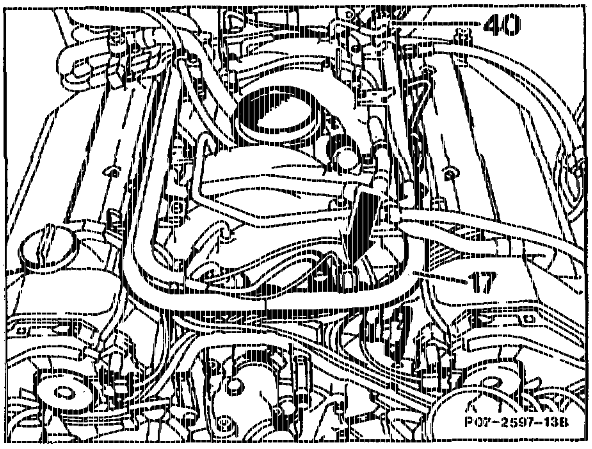


e) Distribution pipe

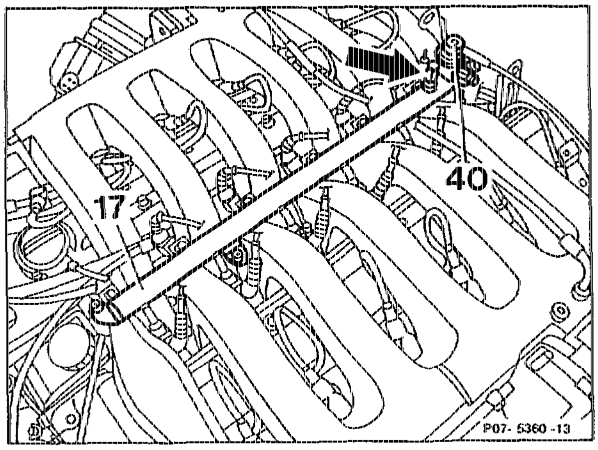
The distribution pipe (17) ensures a uniform fuel pressure at all the injection valves and at the same time acts as a fuel accumulator. Its volume is sufficiently large to prevent pressure variations. A connection with valve (arrow) for checking the fuel pressure is provided on the distribution pipe.



Engine 104



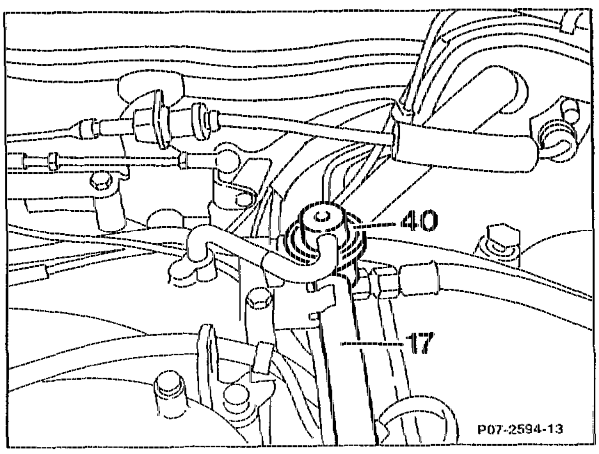
Engine 119



Engine 120

f) Diaphragm pressure regulator

The pressure regulator (40) is fitted at the end of the distribution pipe. It is a diaphragm-controlled overflow pressure regulator which controls the fuel pressure in the intake manifold between approx. 3.1 and 3.8 bar depending on the absolute pressure. This control pressure cannot be altered.

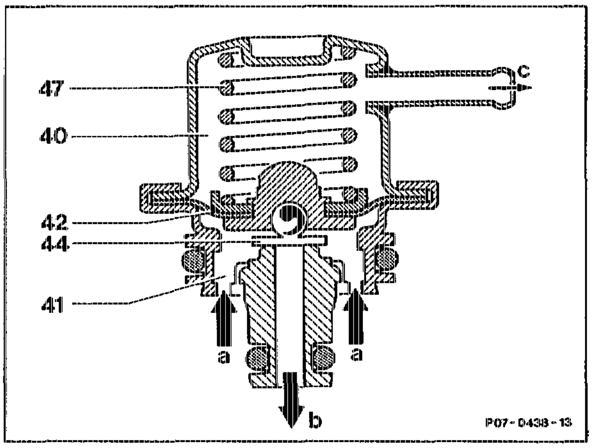


Shown on engine 119

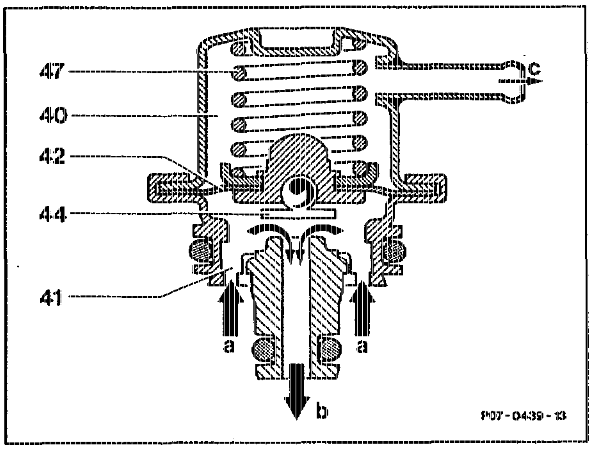
Function of the diaphragm pressure regulator

It consists of a metal housing which is divided by means of a diaphragm (42) into spring chamber (43) and fuel chamber (41).

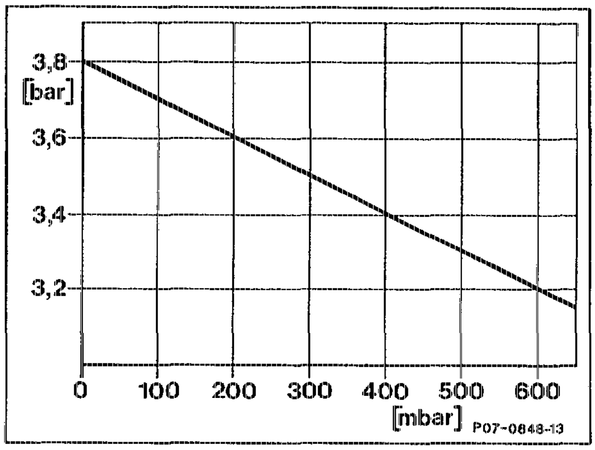
If the pressure of the inlet (a) rises above the set pressure, the spring (47) is over-tensioned by the diaphragm (42) and the valve (44) opens the return passage (b) to the fuel tank. The spring chamber is connected to the intake manifold by a vacuum connection (c).



The vacuum connection (c) counteracts the effect of the spring (47), as a result of which the fuel pressure is reduced (see fuel pressure diagram). This causes the fuel pressure in the distribution pipe to be dependent on the absolute pressure in the intake manifold and the pressure drop via the injection valves is the same no matter the throttle valve position. Consequently, the quantity of fuel injected is determined solely by the opening time of the injection valves.



Fuel pressure diagram



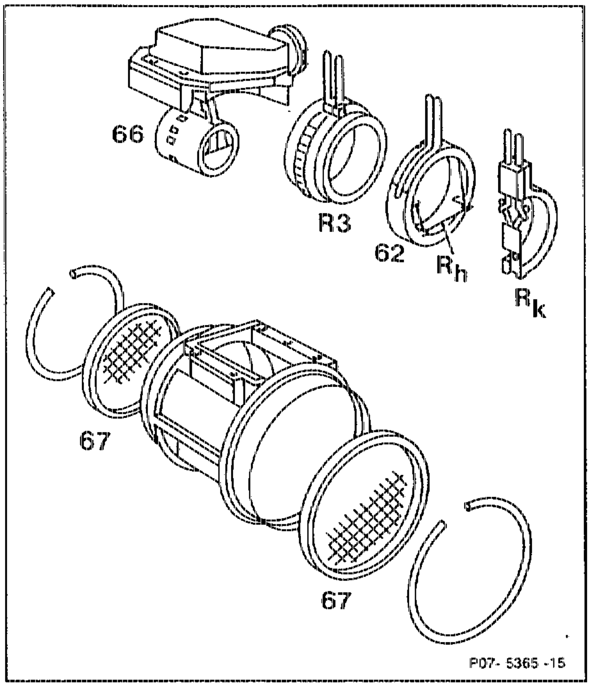
Fuel pressure in bar
Intake manifold vacuum in mbar

C. Mixture preparation

a) Air mass sensor with hot wire

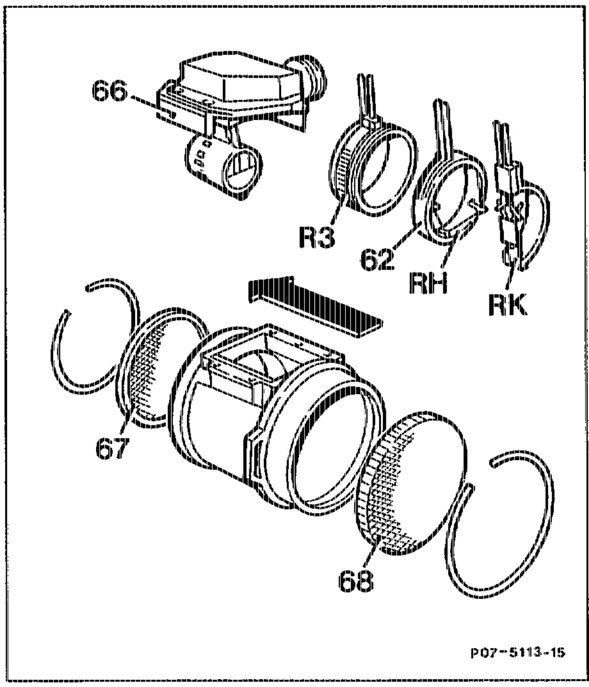
Design

A thin platinum wire (R_H) is tensioned inside a measuring tube. The inner measuring tube consists of two plastic halves in which the hot wire retaining ring (62), the measuring resistor (R3) and the compensation resistor (R_K) are installed.
The electronic part with a hybrid circuit (66), which is connected directly to the LH control unit, is located on the housing.
The measuring device is protected from damage by a protective grille (67) at each end. In addition, turbulences are rectified so that the hot wire is always subjected to uniform flow.



Engine 120

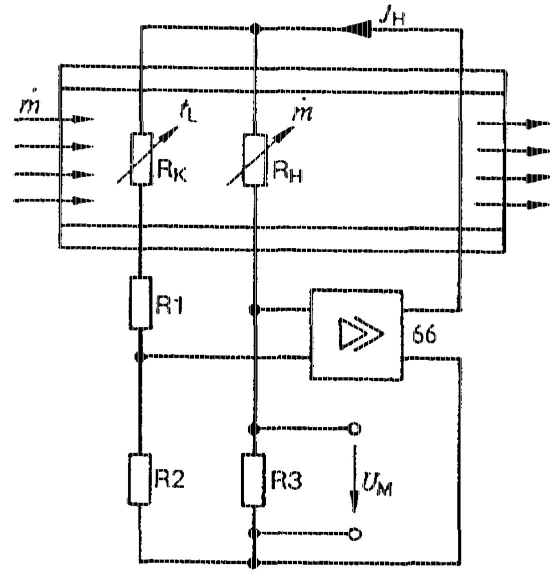
A laminator (68) is fitted at the air inlet of the respective air mass sensor for engine 120 in place of a protective grille. This rectifies turbulences and ensures the hot wire is exposed to a uniform flow of air.



Function

The air mass sensor operates with a thin, heated hot wire made of platinum (R_H) in the intake air flow. The components, hot wire (R_H), compensation resistor (R_K) and measuring resistor (R3) are combined to form a bridge circuit.

The hot wire is a temperature-dependent resistor which increases its resistance as the temperature rises. In operation, the resistor is energized to such an extent with a current (J_H) that it is heated by about 180 °C above the momentary air temperature. This temperature difference is maintained at a constant level. The momentary air temperature is detected by the compensation resistor (R_K), which is positioned upstream of the hot wire, and signalled to the control amplifier (66). When the air throughput increases, the hot wire is cooled as a result of which its electrical resistance decreases. In order to maintain the temperature at the hot wire at a constant level, the heating current (J_H) is immediately regulated to match.



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Because of the low mass of the hot wire, regulation to a constant temperature is completed within a few milliseconds. As the heating current flows through the measuring resistor (R3), a change in current can be detected as a result of the air mass change as a voltage drop at the measuring resistor. The heating current ranges between 500 and 1200 mA, depending on the air mass. This voltage drop is for the LH control unit the measured variable for the mass of air inducted. Temperature variations of the intake air are balanced by the compensation resistor (R_K) so that the air mass signal is not affected. The air mass sensor hot wire has no moving parts and causes only minor flow resistance in the intake air port.

Demand-controlled cleaning operation

Deposits may form on the hot wire as a result of dirt which may influence its resistance and thus the result of the measurement.
For this reason, the hot wire is heated to approx. 1000 °C for about 1 second 4 seconds after switching off the engine provided the following conditions are met:

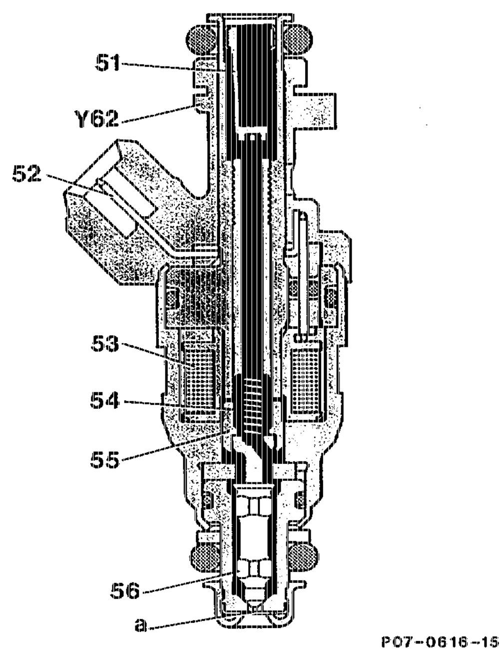
1. coolant temperature above 60 °C
2. engine speed has exceeded 1650 rpm once
3. an air mass of more than 3000 kg has been inducted
   or
4. at least 10 starting operations have been performed.

Emergency running properties

The LH gasoline injection system features excellent emergency running properties. Should the hot wire of the air mass sensor fail because of a short-circuit or open-circuit, the injection time is calculated from the intake manifold absolute pressure. The pressure conditions in the intake manifold are detected in this case by the pressure sensor in the EZL ignition control unit and passed via the serial databus (CAN) to the LH control unit.

b) Fuel injection valve

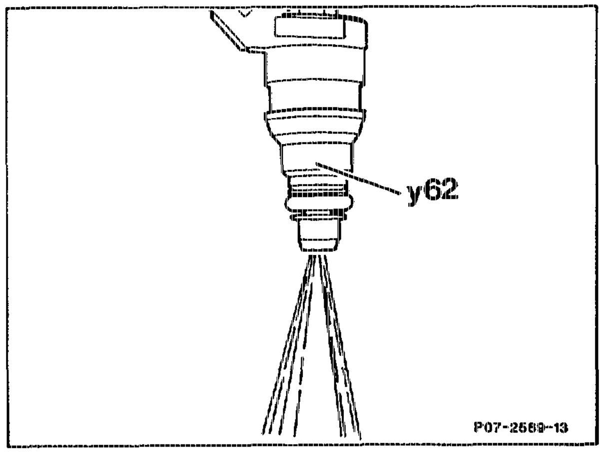
The fuel is injected by means of electromagnetic injection valves (Y62). An injection valve is assigned to each cylinder and injects the fuel in a precisely metered quantity into the intake duct upstream of the inlet valve.
The injection valve consists of a valve body and the nozzle needle (56) with mounted magnetic armature (55). The valve body contains the magnetic winding (53) and the guide for the nozzle needle.
The fuel flows through a prefilter (51) and a passage in the magnetic armature to the calibrated outlet opening (a). When the magnetic winding is deenergized, the nozzle needle is pressed onto its sealing seat by means of a coil spring (54).
If the magnetic winding is energized, the nozzle needle is raised about 0.1 mm off its seat and the fuel flows out through the 4 0.2 mm dia. openings (a). The opening and closing time of the valve is less than 1 ms.



Note

The positive and negative polarization at the fuel injection valves must not be mixed up.

As a result of the positioning of the openings, two jets are formed when the fuel flows out, which spray directly onto the two inlet valves.



c) Actuation of the injection valves and fuel metering in different operating states

General

The fuel is injected by electromagnetic injection valves. An injection valve is assigned to each cylinder which injects the fuel in a precisely metered flow into the suction tube upstream of the inlet valves. The injection valves are connected directly to positive and are opened by negative pulses supplied by LH control unit. The injection valves are controlled in line with the firing order. The fuel is injected more or less advanced, depending on engine load and engine speed, and is sucked together with the air into the combustion chamber after the inlet valves open. The LH control unit calculates the injection time in line with the operating state of the engine. The quantity of fuel injected is determined by opening time of the injection valve.

Basic quantity of fuel injected

The basic quantity of fuel injected is influenced by the LH control unit depending on the operating state of the following components:

- air mass sensor with hot wire
- engine speed signal (TN)
- position of resistance trimming plug

Start control

To facilitate starting the cold engine, additional fuel must be injected during the starting operation, depending on the coolant temperature. The increased quantity of fuel injected is achieved by extending the injection time.
The start control begins with the starting operation via terminal 50 and remains activated until a temperature-dependent engine speed is exceeded.

The quantity of fuel required for starting is calculated independently by the air mass sensor with hot wire from the following factors:

- coolant temperature
- camshaft speed (camshaft position sensor)
- intake manifold pressure (EZL ignition control unit)
- time for which engine was switched off

Post-start enrichment
After starting a cold engine, the mixture must be enriched with additional fuel for a short time. This compensates for the increased fuel precipitation and the engine runs smoothly. Post-start enrichment is dependent on:

- coolant temperature at starting
- period of time following starting
- selector lever position
- position of resistance trimming plug

Warming-up enrichment
The engine is allocated the exact quantity of fuel irrespective of the coolant temperature. This is done by extending the injection time accordingly. Warming-up enrichment is dependent on:

- coolant temperature at starting
- intake air temperature
- engine speed/engine load
- idle speed/part load operation
- position of resistance trimming plug

Acceleration enrichment

In order to achieve good throttle response during acceleration, the injection valves are actuated with additional pulses. Acceleration enrichment is dependent on:

- coolant temperature
- engine speed/engine load
- load change speed
- position of resistance trimming plug

Deceleration fuel shutoff

When the vehicle is decelerating (accelerator pedal in idle position) fuel injection is switched off in 2 stages if the engine is at normal operating temperature (coolant temperature >70 °C).

Engine 104

In the 1st stage 3 and in the 2nd stage all 6 injection valves are switched off. The speeds at which the valves are switched off and on are presented in the table below.

Engine speed	Valves switched off	Engine speed dropping (deceleration) ↓
>1690/min	6	6
<1690/min	3 (every 2nd valve)	6
<1100/min	0	6
<1000/min	0	3 (every 2nd valve)
<600/min	0	0
	↑ Engine speed rising (descent)	Valves switched off

Note

The engine speed thresholds are appropriately higher at coolant temperatures below 70 °C. Deceleration fuel shutoff is deactivated if the coolant temperature is below 50 °C.

Engine 119

When the vehicle is decelerating (accelerator pedal in idle position), fuel injection is switched off in 2 stages if the engine is at normal operating temperature (coolant temperature >70 °C).

In the 1st stage 4 and in the 2nd stage all 8 injection valves are switched off. The engine speeds at which the valves are switched off and on are presented in the table below.

Engine speed	Valves switched off	Engine speed dropping (deceleration) ↓
>1240/min	8	8
<1240/min	4 (every 2nd valve)	8
<1150/min	0	4 (every 2nd valve)
<950/min	0	0
<600/min	0	0
	↑ Engine speed rising (descent)	Valves switched off

Note

The engine speed thresholds are appropriately higher at coolant temperatures below 70 °C.

Engine 120

When the vehicle is decelerating (accelerator pedal in idle speed position), fuel injection is switched off in 4 stages if the engine is at normal operating temperature (coolant temperature >70 °C).

In the 1st stage 3, in the 2nd stage 6, in the 3rd stage 9 and in the 4th stage all 12 injection valves are switched off. The engine speeds at which the valves are switched off and on are presented in the table overleaf.

Engine speed	Valves switched off	Engine speed dropping (deceleration) ↓
> 1330/min	12	12
< 1330/min	6 (every 2nd valve)	9
< 1220/min	3	9
< 1195/min	3	6 (every 2nd valve)
< 1095/min	0	3
< 1000/min	0	0
	↑ Engine speed rising (descent)	Valves switched off

Note
The engine speed thresholds are appropriately higher at coolant temperatures below 70 °C.

Top speed control

Engines 104, 119
Top speed is limited to approx. 250 km/h. If this speed is exceeded, the LH control unit alters the mixture to a leaner mixture and advances the camshafts.

Engine 120
Top speed is limited to 250 km/h by the electronic accelerator pedal. In contrast to engines 104 and 119, no top speed control is activated in the LH control unit.

Governing engine speed

Fuel injection is interrupted if the following engine speeds are exceeded in order to protect the engine:

Brief governed speed (example)

Engine 104	Engine 119	Engine 120
6900 + 50/min for 5 seconds	6300 + 50/min for 10 seconds	6200 + 50/min for 5 seconds

Continuous governed speed (example)

Engine 104	Engine 119	Engine 120
6700 + 50/min	6000 + 50/min	6000 + 50/min

The brief governed speed is restored once engine speed has dropped below the following levels:

Governed speed (example)

Engine 104	Engine 119	Engine 120
6500/min	5500/min	5000/min

Engine speed in driving modes P, N or R is governed at the following levels:

Governed speed (example)

Engine 104	Engine 119	Engine 120
5500/min	5600/min	5100/min

If the road speed signal is interrupted, engine speed is limited in Drive modes B, 2, 3 or D in order to prevent top speed exceeding 250 km/h.

Governed speed (example)

Engine 104	Engine 119	Engine 120
5700/min	5600/min	5250/min

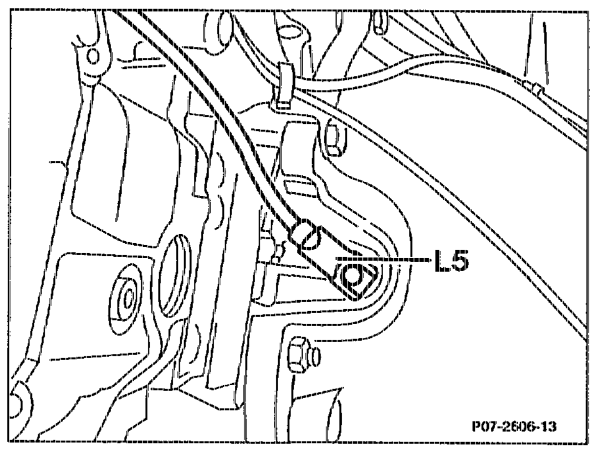
Fuel safety cutoff
The LH control unit is connected for this safety function by a separate cable with switching contacts in the electronic accelerator pedal actuator. At idling speed or when driving, the switching contacts pass a positive signal to the LH control unit.
If the throttle valve is opened further than specified by the accelerator pedal because of a malfunction and the Tempomat cruise control is not in use, a safety contact in the actuator (M16/1) switches a ground signal to the LH control unit via the electronic accelerator pedal control unit. This interrupts fuel injection, which is restored again at a certain engine speed depending on the engine (see table).

Engine	Fuel injection restored
104	1200 /min
119	1100 /min
120	1300 /min

D. Influencing parameters for control

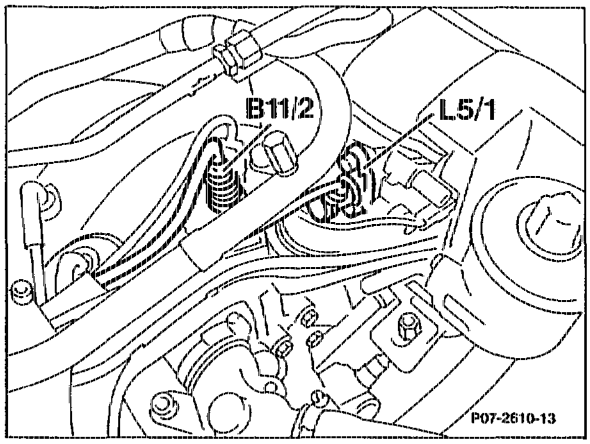
a) Engine speed
The information regarding engine speed is supplied by the crankshaft position sensor (L5, engine 120 L5/4 and L5/5) in the form of an alternating voltage to the EZL ignition control unit. This alternating voltage is processed in the ignition control unit and passed as a square wave signal (TN signal) via the serial databus (CAN) to the LH control unit.

Shown on engine 119



b) Camshaft speed

The injection sequence must be synchronized in order to ensure that the moment of injection is correctly matched to the respective cylinder. The signal of the camshaft position sensor (L5/1, engine 120 L5/2 and L5/3) is required for this purpose. The camshaft position sensor produces two alternating voltage signals for each rotation of the camshaft. These are processed to square wave signals in the EZL ignition control unit and passed to the LH control unit.

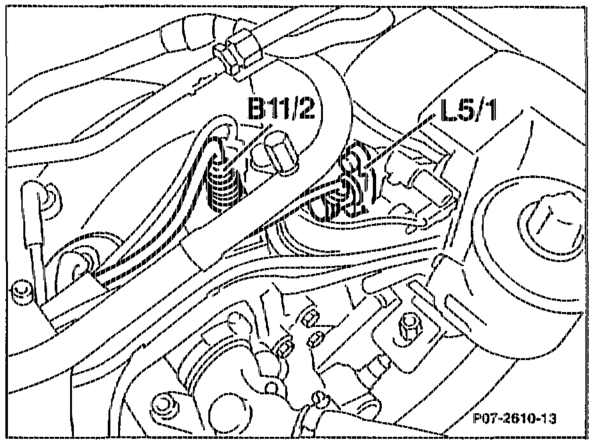


Shown on engine 119

c) Coolant temperature

Two NTC coolant temperature sensors (B11/2) in the coolant circuit detect the coolant temperature and converted into electrical signals. These signals are processed in the LH control unit and produce a correction of the injection time when the engine is cold. This results in a richer fuel/air mixture.

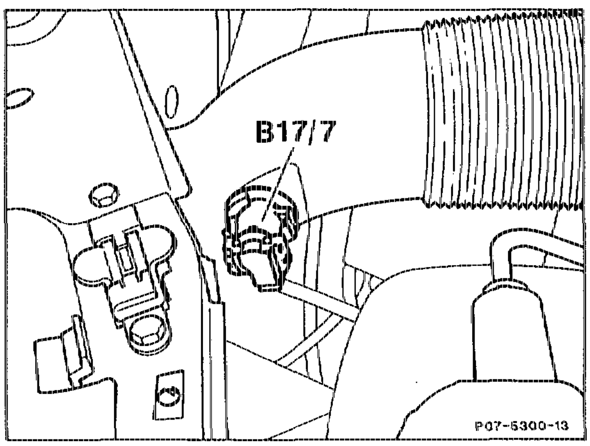
NTC = resistor with negative temperature coefficient. The resistor manufactured from a semiconductor reduces its electrical resistance as temperature rises.



Shown on engine 119

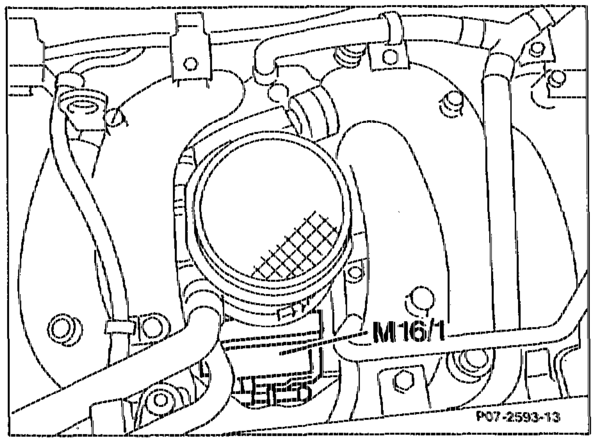
d) Intake air temperature

The intake air temperature sensor (B17/7) influences the quantity of fuel injected so that the engine runs smoothly when cold. The mixture is additionally corrected toward a richer mixture at low intake air temperature.
The intake air temperature sensor, like the coolant temperature sensor, is an NTC resistor.



Shown on engine 119, model 140

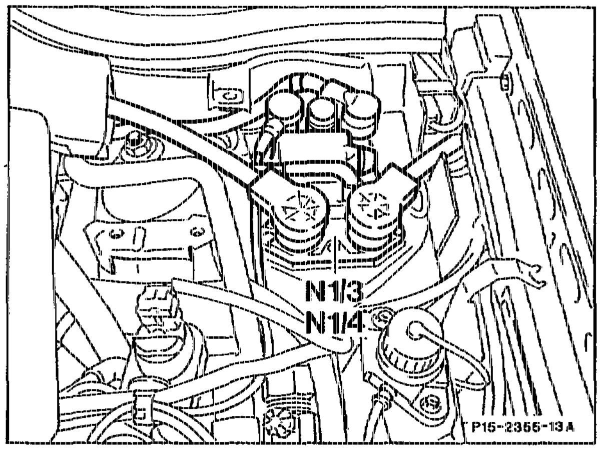
e) Idle speed and full load recognition
The idle speed and full load operating states are detected by potentiometers in the electronic accelerator pedal actuator (M16/1, engine 120 M16/3 and M16/4) or in the Tempomat cruise control/idle speed control actuator (M16/2) and passed via the serial databus (CAN) to the LH control unit. The idle speed signal is passed along an additional cable to the LH control unit. Idle speed recognition is required for decel fuel shutoff as well as for enrichment when the engine is cold and full load recognition is required for full load enrichment or full load correction.



Shown on engine 119

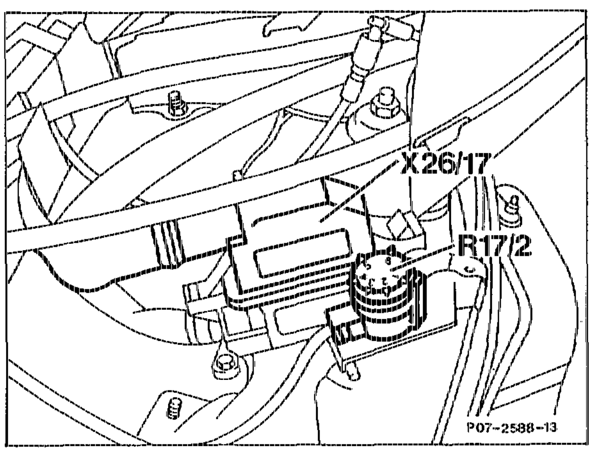
f) Absolute pressure in intake manifold
The pressure conditions in the intake manifold are detected by the pressure sensor in the EZL ignition control unit (N1/3) and passed via the serial databus (CAN) to the LH control unit. This information is required for the following operating states:

- during starting up to an engine speed of approx. 600/min
- after failure of the air mass sensor with hot wire over the entire engine speed range for emergency running



Shown on engine 119, model 140

g) Adaptation of fuel injection maps by means of resistance trimming plugs
All vehicles (except USA/California) have a resistance trimming plug (R17/2) for adapting various fuel injection maps. With this resistance trimming plug the basic quantity can be increased, warming-up, post-start and acceleration enrichment can be set in defined stages. A total of 7 stages are possible. Correction possibilities by means of resistance trimming plug (see Diagnosis Manual Engine Volume 2).



Shown on engine 119, model 140

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On vehicles with catalytic converter and national version (J) a white resistance trimming plug must **not** be fitted otherwise the air pump for the air injection will constantly run and this may cause damage to the air pump.

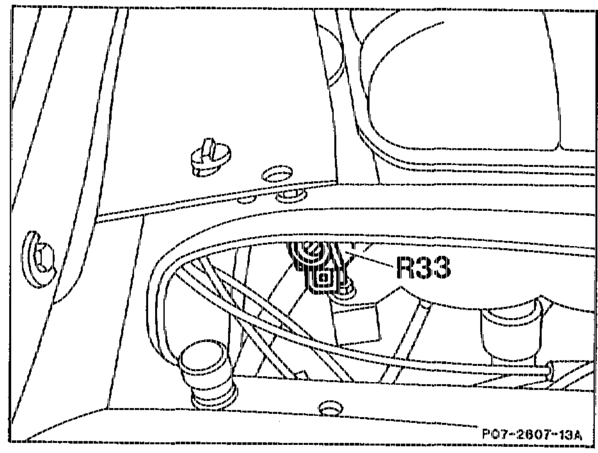
Green resistance trimming plug
= vehicles with KAT
White resistance trimming plug
= vehicles without KAT

h) Idle speed CO correction

Vehicles **without KAT** are fitted with a CO potentiometer (R33, engine 120 R33/1 and R33/2) for setting the idle speed emissions level.

Turning to the left	**leaner**
Turning to the right	**richer**

Vehicles with KAT have no facility for setting the idle speed emissions level as mixture adaptation is performed by the lambda control.



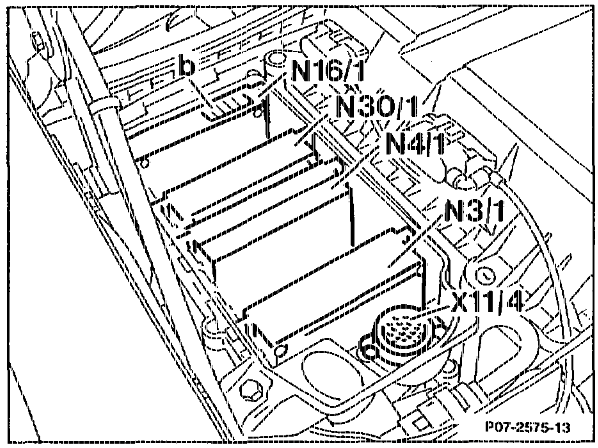
Shown on engine 119, model 140

i) Battery voltage and voltage supply

The quantity of fuel injected by the electromagnetic injection valves is dependent on the opening times of the injection valves. These opening times are influenced by the battery voltage. In order to balance the quantity of fuel injected in the case of a different battery voltage, the LH control unit corrects the injection time, e. g. :

battery voltage lower = opening time longer
battery voltage higher = opening time shorter

The voltage supply for the LH control unit and also for the injection valves is provided by the base module (GM, N16/1). This is located in the module box and is colour coded black. The overvoltage protection previously fitted is therefore discontinued.
The voltage supply, terminal 15, is protected by fuse F2. The voltage supply, terminal 30, is passed by the base module (GM) unprotected to the LH control unit.



Shown on engine 119, model 140

E. Functions in the control unit

a) General

The lambda control determines the injection time so exactly that the fuel/air ratio is always around lambda 1.0 (corresponds to 14.7 kg air to 1 kg fuel) in all operating states. If faults occur as a result of:

- ingress of air
- wear or coking of fuel injection valves
- wear to engine
- contact resistance in air mass sensor
- faulty diaphragm pressure regulator
- faulty regeneration switchover valve

the LH control unit automatically performs a correction of the mixture formation by altering the injection time.
The correction parameters are constantly calculated and permanently stored provided the following conditions are met:

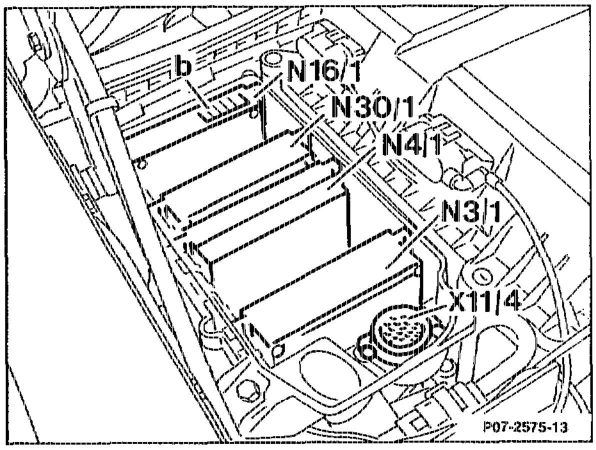
- coolant temperature when starting between 15 °C–65 °C,
- coolant temperature when driving between 80 °C–100 °C,
- intake air temperature between 0 °C–50 °C.

There are two ranges in which self-adaptation is performed, these being idle speed and part load. The correction toward a rich or lean mixture is not more than 25 % in each case.
Following repairs to the fuel injection system or to the engine, the LH control unit automatically adapts once again after several trips. After installing the LH control unit from another vehicle as a test or rectifying the fault stated above, self-adaptation must be reset to the average value (see Resetting and reactivating memory of LH control unit, Diagnosis Manual Engine, Volume 2).

Engine 104, 119

The LH control unit (N3/1) is designed as a module and is located in the module box. The colour coding is dark green/light green. It analyzes the data supplied by the sensors regarding the operating state of the engine and calculates from these the opening time for the injection valves. The quantity of fuel injected is determined by the opening time of the injection valves.

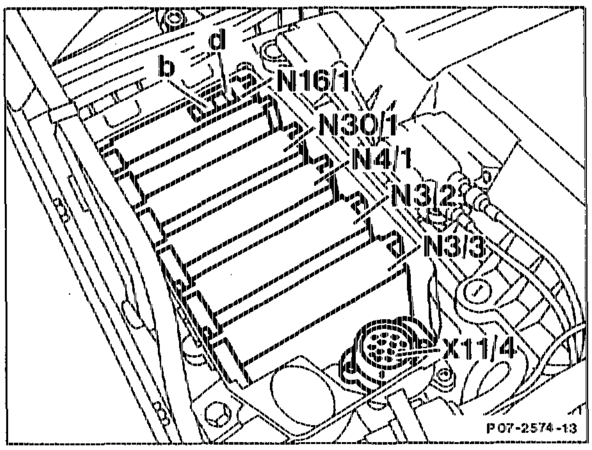
In addition, it features an interface to the serial databus (CAN) which makes use of serial data transfer and thus enables a number of otherwise necessary additional inputs and outputs as well as sensors to be dispensed with.



Engine 120

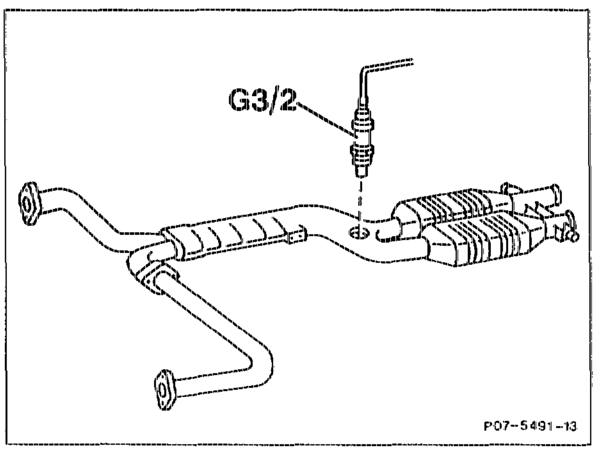
Two control units are required: right LH control unit (N3/3) for cylinders 1–6, colour coding dark green/light green, and left LH control unit (N3/2) for cylinders 7–12, colour coding dark blue/light blue.

To distinguish which control unit is responsible for the left and which for the right bank of cylinders, the left LH control unit (N3/2) is laid to ground (coded) at connection 1.2 (see Wiring Diagrams Model 140, Volume 1).

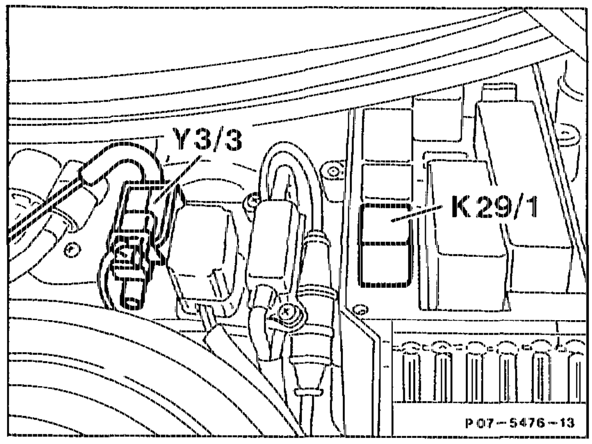


b) Lambda control (only KAT)

The LH control unit receives a signal from the oxygen sensor describing the residual oxygen content in the exhaust. The LH control unit corrects the quantity of fuel injected on the basis of this signal (see 14–0030, Section "D and E").



c) Transmission shift point retard

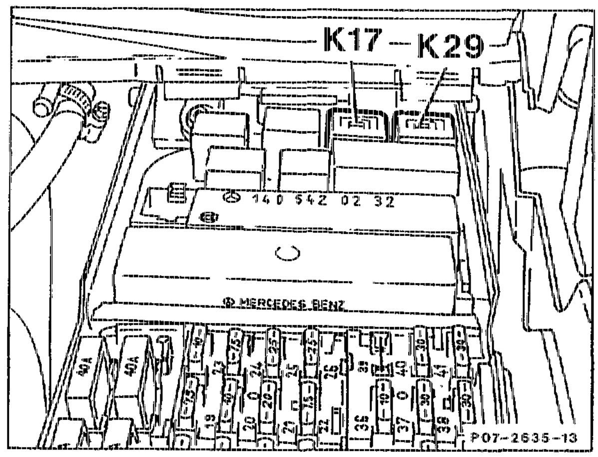


1→2

On model 124.034 (J), (USA), to enable the catalytic converter to heat up more rapidly, the 1→2 upshift in the automatic transmission is retarded at a coolant starting temperature <40 °C as follows:

- After a speed of 8 km/h is exceeded for 8–13 s or up to max. 38 km/h.

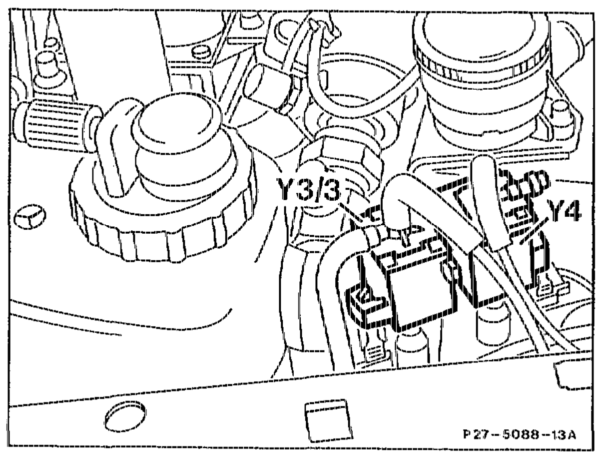
This is controlled by the LH control unit and the 1st gear starting off relay (K29/1). The 1st gear starting off relay is located in the relay and fuse box in sector "E".



2→3

(only KAT version)

To enable the catalytic converter to more rapidly reach its operating temperature in the warming-up phase, the 2→3 upshift at idle speed and part load in the automatic transmission is retarded between a coolant temperature of 0 °C up to 50 °C for not more than 15 seconds after starting. The engine thus revs at a slightly higher speed before shifting up. This is controlled by the LH control unit and the transmission shift point retard relay (K29).



The control unit (N3/1) actuates the switchover valve (Y3/3) with ground depending on the coolant temperature, vehicle speed and time. The vacuum element at the transmission is then pressurized with vacuum through the switchover valve.

Model 140

d) Camshaft adjustment (inlet camshafts)

The inlet camshafts are advanced depending on engine speed and load in order to achieve favourable engine torque over the entire speed range.
An actuator is fitted to the camshaft adjusters which operates the control plunger for the hydraulic/mechanical adjustment. The actuators are controlled by the LH control unit.

If the actuators are operated, the inlet camshafts are advanced. The adjustment depends on engine load and speed. If the selector lever is in position P or N, the adjustment is dependent only on engine speed.

Engine speed	Position of camshaft		
	Engine 104	Engine 119	Engine 120
< 2000/min	retarded [1]	retarded [1]	retarded [1]
>2500/min	advanced [2]	advanced [2]	advanced [2]
2000–4200/min	–	advanced [1]	–
2000–4400/min	–	–	advanced [1]
2000–4700/min	advanced [1]	–	–
>4200/min	–	retarded [1]	–
>4400/min	–	–	retarded [1]
>4700/min	retarded [1]	–	–
more than 250 km/h	–	advanced	advanced

1) Selector lever in Drive mode and average load.
2) Shift point is advanced at 3000/min in selector lever position P/N.

e) Fuel cutoff in the event of ignition faults

To prevent the catalytic converter overheating as a result of uncombusted fuel if ignition faults exist, the ignition faults are detected by the EZL ignition control unit and signalled via the serial databus (CAN) to the LH control unit.
Depending on the type of fault, either the fuel for the cylinder in question (cylinder-selective) or for the cylinders of the ignition circuit in question are switched off by the LH control unit.

Cylinder-selective fuel cutoff
Misfiring is detected by means of primary monitoring of the combustion voltage and combustion time of the ignition spark and the fuel for the cylinder in question is cut off. Once misfiring no longer exists, the fuel supply is restored if engine load has dropped below a certain level (throttle valve almost closed) and engine speed has exceeded 2480/min (see Diagnosis Fault Memory, Diagnosis Manual Engine Volume 2).

Ignition circuit fuel cutoff
The following ignition faults are detected by monitoring the primary current:

- fault in output stage in the EZL ignition control unit
- fault in ignition coil and open circuit in wiring.

If these types of ignition faults exist, the fuel to all the cylinders of the ignition circuit in question is cut off. The ignition faults are stored in the ignition control unit (see Diagnosis Fault Memory, Diagnosis Manual Engine Volume 2).

f) Idle speed control

The idle speed control is operated by the electronic accelerator pedal control unit (N4/1). The data required for controlling engine speed are supplied to the electronic accelerator pedal control unit by the LH control unit through the serial databus CAN.

g) Electronic accelerator pedal

For operation of the electronic accelerator pedal see Group 30.

h) Diagnostics

The LH control unit features the following diagnostic facilities:

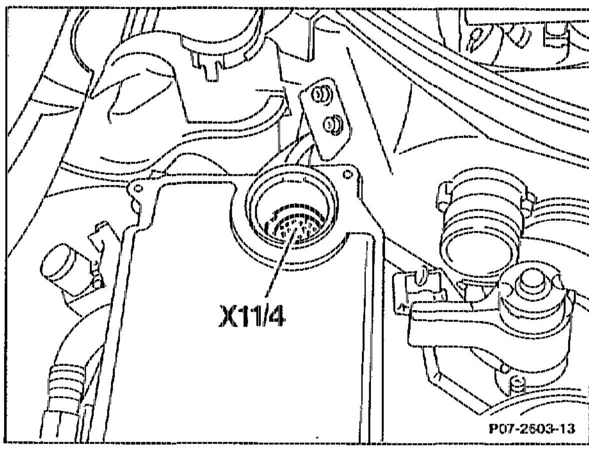
1. Diagnostics with fault memory

Faults which occur when the engine is running are counted by a fault counter.
Such a fault is not stored by the fault memory unless it still exists after the engine has been started 4 times.

This avoids faults, which have only occurred once for example, being stored. If a fault occurs less than 4 times, the fault counter is erased again after a certain number of starts.
Faults which prevent the engine starting or severely affect engine running, are stored immediately.
The fault memory is not erased when the battery is disconnected.

The stored faults can be read with the pulse counter at the diagnostic test coupling (X11/4) (see Diagnosis Manual Engine Volume 2).

⚠
The engine must not be running and the ignition must be switched on in order to read the fault memory.



2. On/off ratio output

Operation of the lambda control can be tested and non-stored faults which occur only momentarily, can be detected by means of the on/off ratio.
A distinction is made when reading the faults between "ignition on" and "engine idling" (see Diagnosis Manual Engine Volume 2).

i) Emergency running programme (plausibility circuit)

The LH control unit features an emergency running programme. All the input signals are continuously detected.
If the input of these signals is no longer plausible, the LH control unit automatically forms a substitute value for the implausible signal. This ensures that the injection system continues operating practically fault-free.
If, for example, the coupling is unplugged at the coolant temperature sensor when the engine is at normal operating temperature, the control unit detects the interruption and switches over to emergency running mode. A slow change in a value is only detected by the LH control unit once the value is implausible.

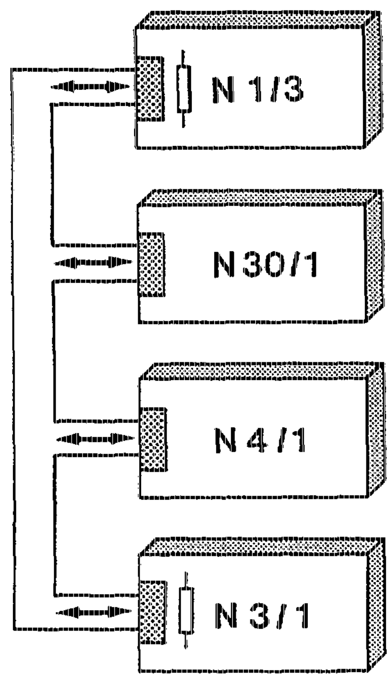
j) Data interchange via serial databus (CAN)

Engine 104 and engine 119 (except USA)

The LH control unit (N3/1), electronic accelerator pedal control unit (N4/1) and ABS/ASR control unit (N30/1) as well as the EZL ignition control unit (N1/3) are interlinked by a serial databus (CAN).

CAN = Controller Area Network

The control units are interlinked in parallel by two wires.
This enables additional sensors as well as inputs and outputs to be dispensed with.
Data transfer is performed constantly in information blocks. What one control unit transmits is received by the other control units, and vice versa.
In this system, the control units receive only the data which they require. Important data are handled on a priority basis (see data which are transmitted via the serial data line).



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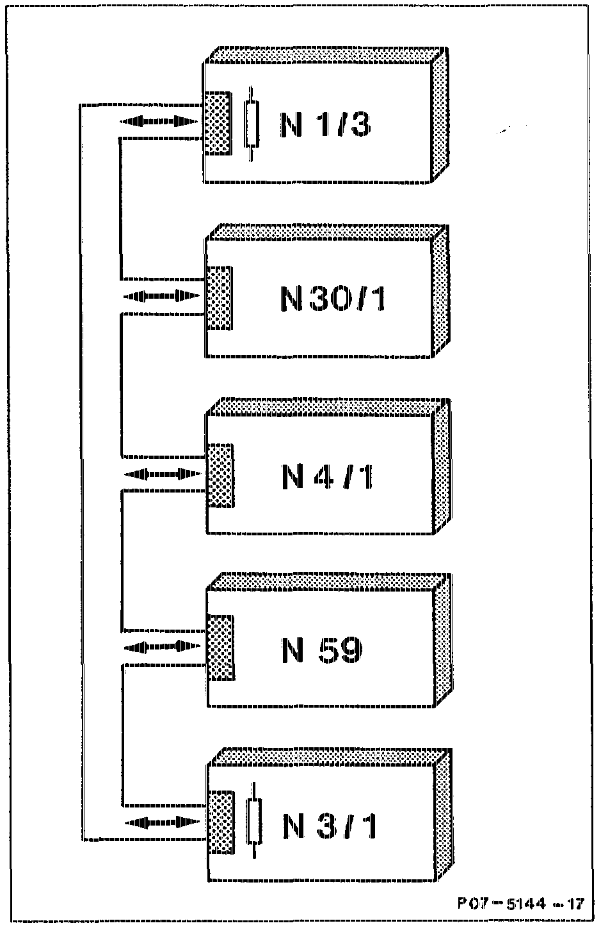
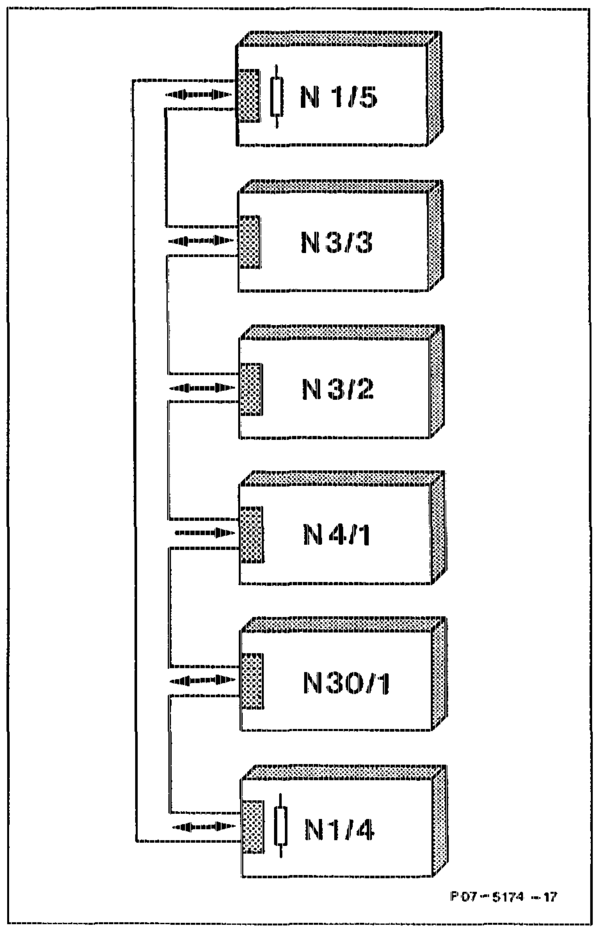
Engine 119 (USA)



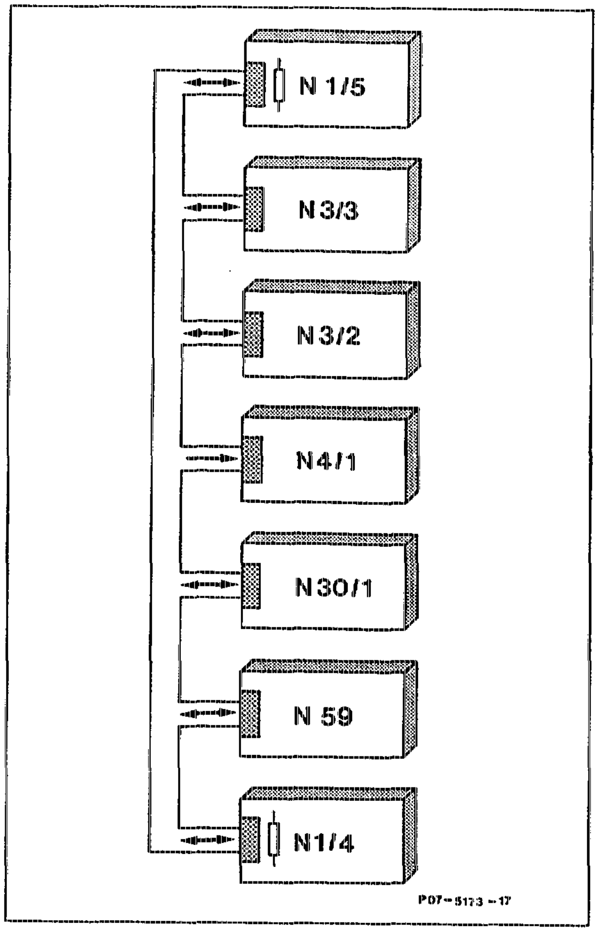
N1/3 EZL ignition control unit
N3/1 LH control unit
N4/1 Electronic accelerator pedal (EFP) control unit
N30/1 ABS/ASR control unit
N59 Diagnostic module

Engine 120 (except USA)



N1/4 Left EZL ignition control unit
N1/5 Right EZL ignition control unit
N3/2 Left LH control unit
N3/3 Right LH control unit
N4/1 Electronic accelerator pedal (EFP) control unit
N30/1 ABS/ASR control unit

Engine 120 (USA)



N1/4 Left EZL ignition control unit
N1/5 Right EZL ignition control unit
N3/2 Left LH control unit
N3/3 Right LH control unit
N4/1 Electronic accelerator pedal (EFP) control unit
N30/1 ABS/ASR control unit
N59 Diagnostic module

Data which are transferred via the databus (CAN) (except USA)

EZL ignition control unit (N1/3)

transfers

- engine speed
- load value limit
- KAT heating
- transmission overload protection on
- ignition angle advance
- transmission switch in gear 2
- ignition faults of respective cylinder
- intake manifold absolute pressure

Electronic accelerator pedal (EFP) /idle speed control unit (N1/4)

transfers

- selector lever position
- Economy/Standard (S/E)
- momentary slip control
- throttle valve actual value
- throttle valve specified value
- road speed signal
- KAT heating on
- idle speed
- full load
- Tempomat cruise control on
- stop lamp switch on
- emergency running mode
- maximum speed
- throttle valve compulsory closing

to

LH control unit (N3/1)

transfers

- long injection time
- short injection time

to

electronic accelerator pedal (EFP) control unit

- control unit recognition
- KAT heating
- air throughput limit
- exhaust gas recirculation
- air pump
- decel fuel cutoff
- camshaft adjustment
- transmission shift point retard
- acceleration enrichment
- end of starting
- regeneration
- coolant temperature
- air throughput (air mass sensor)
- intake air temperature

to

electronic accelerator pedal (EFP) control unit and **EZL ignition control unit (N1/3)**

Data which are transferred via the databus (USA)

Shown on engine 119

EZL ignition control unit (N1/3)

transfers

- engine speed
- load value limit
- KAT heating
- transmission overload protection on
- ignition angle advance
- transmission switch in gear 2
- ignition faults of respective cylinder
- intake manifold absolute pressure
- altitude pressure
- warming-up operating

to

Electronic accelerator pedal control unit (N4/1)

transfers

- selector lever position
- fuel safety cutoff
- momentary slip control
- throttle valve actual value
- throttle valve specified value
- road speed signal
- KAT heating on
- idle speed
- full throttle
- Tempomat cruise control on
- stop lamp switch on
- emergency running mode
- maximum speed
- throttle valve compulsory closing
- specified engine speed
- idle speed contact switch
- throttle valve position

to

Diagnostic module (N59)

transfers

- air injection diagnosis request
- exhaust gas recirculation diagnosis request

to

to

to

to

- ABS/ASR not operating
- ASR operating properly
- Tempomat cruise control off
- open throttle valve slightly
- close throttle valve
- ignition angle advance operating

- injection time long

For diagnostic module

- oxygen sensor implausible
- coolant temperature sensor implausible
- intake air temperature sensor implausible
- air mass sensor implausible
- limit for longtime adaptation exceeded
- fault in air pump switchover valve
- fault in exhaust gas recirculation switchover valve
- fault in regeneration switchover valve
- fault at camshaft position sensor
- fault in TN signal
- oxygen sensor rich, lean

- control unit identifier
- post-start
- exhaust gas recirculation
- air pump
- decel fuel cutoff
- camshaft adjustment
- transmission shift point retard
- end of starting
- regeneration
- coolant temperature
- load
- intake air temperature
- starter operating (terminal 50)
- fuel safety cutoff

transfers

transfers

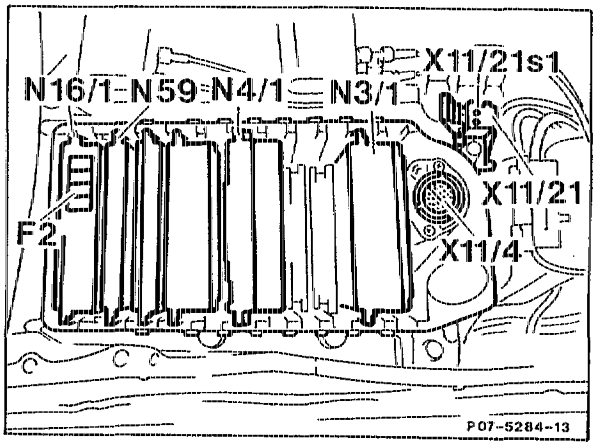
ASR control unit (N30/1)

LH control unit (N3/1)

F. Diagnostic module (California version only)

a) General

The diagnostic module (N59) is located in the module box. It is supplied with power from the base module (N16/1). The colour coding is violet.
Its task is to monitor signals and systems of relevants to exhaust emissions and, if a fault is recognized, to signal this by means of the CHECK ENGINE indicator lamp. At the same time, a fault code is stored in the fault memory of the diagnostic module.



Note

Reading fault memory, see Diangosis Manual Engine Volume 2 and 3.

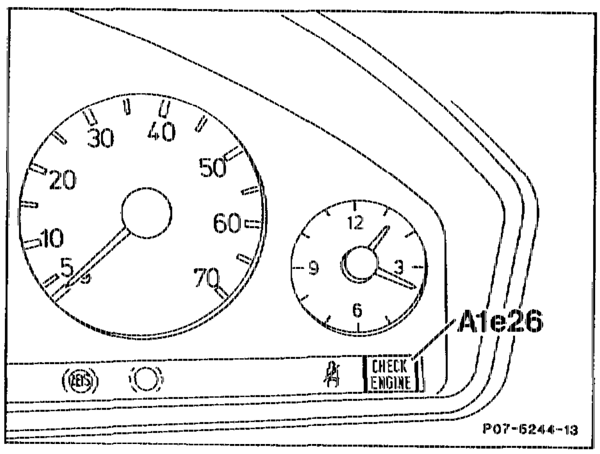
The data required for monitoring are supplied to the diagnostic module via the serial databus (CAN) by the following control units:

- LH control unit (N3/1)
- EZL ignition control unit (N1/3)
- Electronic accelerator pedal control unit (N4/1)
- ABS/ASR control unit (N30/1)

(see also Data which are transferred by the databus (CAN))

b) Operation of CHECK ENGINE indicator lamp

The indicator lamp (A1e26) is supplied with voltage by the base module (N16/1) and controlled with ground by the diagnostic module. As a check, the bulb lights up at "ON" and for up to 30 seconds at an engine speed of about 500/min. If no fault exists, the diagnostic module interrupts the ground to the bulb. The CHECK ENGINE indicator lamp goes out.

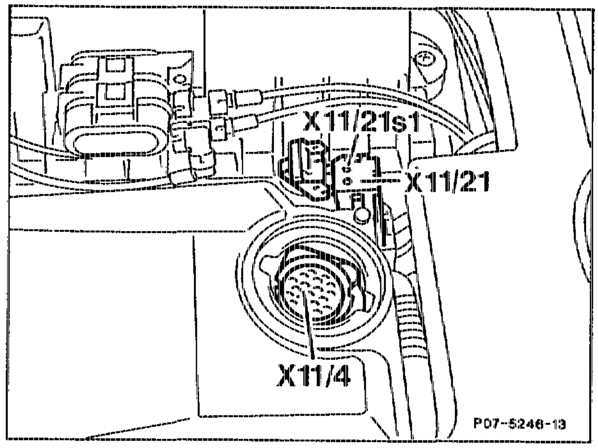


c) Operation of fault memory

The diagnostic module features a fault memory, the contents of which are retained even if the battery is disconnected.
With the ignition switched on, data which are transferred via the databus (CAN) are detected by the diagnostic module.

If a fault occurs when driving, e. g. in the LH fuel injection system, a substitute value (emergency running function) is formed in the LH control unit, the fault registered and signalled to the diagnostic module.

If a fault occurs during two successive trips, it is stored in the fault memory after the engine is switched off and can be read with the pulse counter at the diagnostic socket (X11/4) or with the pushbutton switch and the LED (S1) at the test coupling for diagnostic module (X11/21). At the same time, the CHECK ENGINE indicator lamp lights up when the engine is running until the fault has been rectified and erased.



d) Checking operation of systems

1. Air injection

When the engine is running and the lambda control is operating, the LH control unit first of all checks the electrical functions of

- oxygen sensor
- air pump switchover valve
- air pump electromagnetic clutch

and signals this to the diagnostic module.
If no fault exists, the diagnostic module transmits a signal to the LH control unit which activates the air pump.
The diagnostic module checks whether the oxygen sensor signal is thus indicating a constant "lean". If this is not the case, a fault is recognized and stored as in section c "operation of fault memory" and the CHECK ENGINE indicator lamp lights up.

2. Exhaust gas recirculation

When the engine is running at normal operating temperature, the LH control unit checks the electrical function of the exhaust gas recirculation switchover valve and signals this to the diagnostic module.
If no fault is detected, the diagnostic module signals during a decel fuel shutoff phase (all fuel injection valves switched off) to the LH control unit to operate the exhaust gas recirculation switchover valve.
The diagnostic module checks whether this causes a change in intake manifold pressure ($>$20 mbar). If this threshold was not exceeded, a fault is recognized and stored as in section c "operation of fault memory".