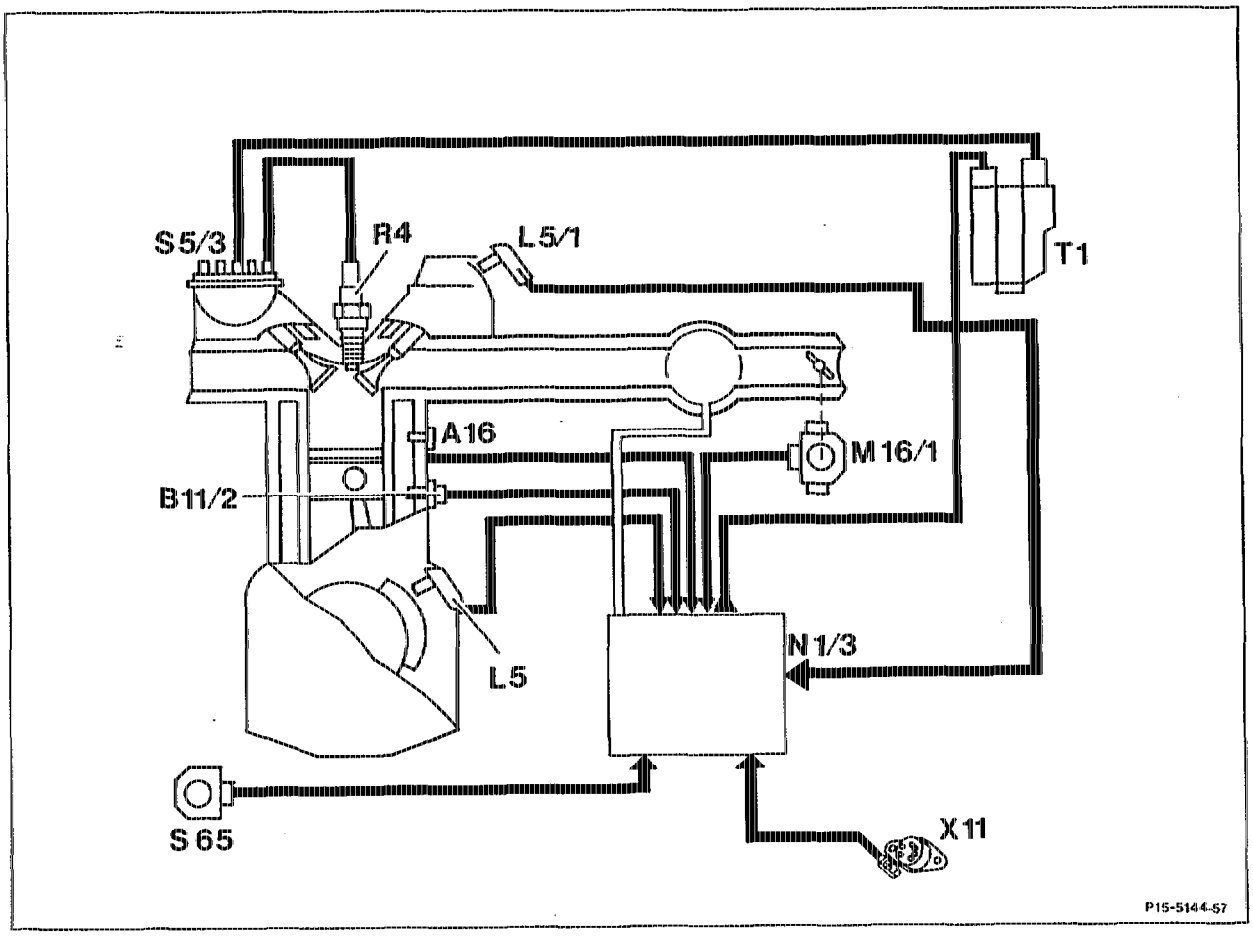
15–0020 Electronic ignition system with variable ignition characteristics and anti-knock control (EZL)

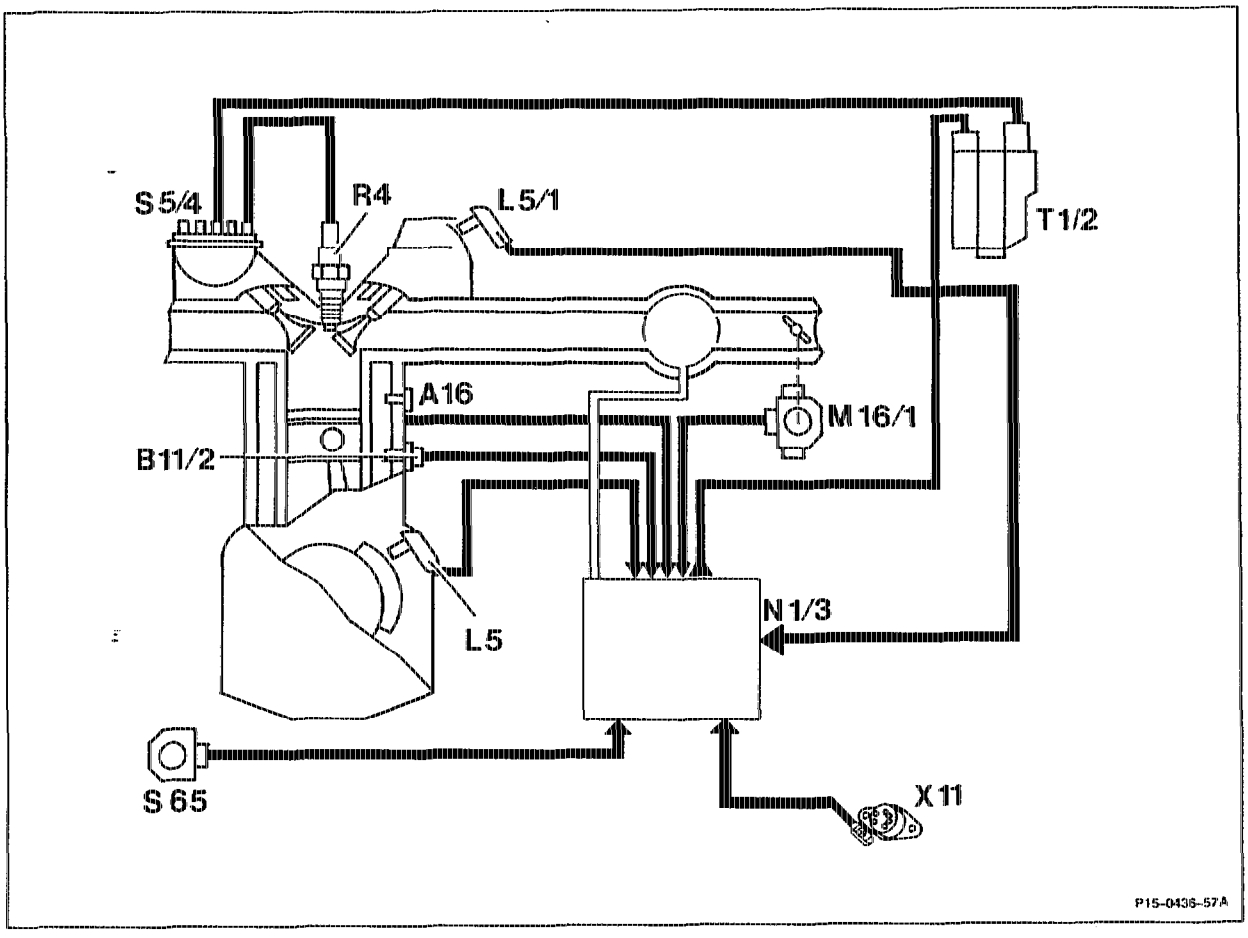
A. Basic function diagram of electronic ignition system (EZL)

a) Engine 104



A16	Knock sensor	R4	Spark plugs
B11/2	Coolant temperature sensor	S5/3	High voltage distributor
L5	Crankshaft position sensor	S65	Transmission overload protection switch, brake band B1
L5/1	Camshaft position sensor		
M16/1	Electronic accelerator pedal (EFP) actuator	T1	Ignition coil
N1/3	EZL ignition control unit	X11	Diagnostic socket, 9-pin

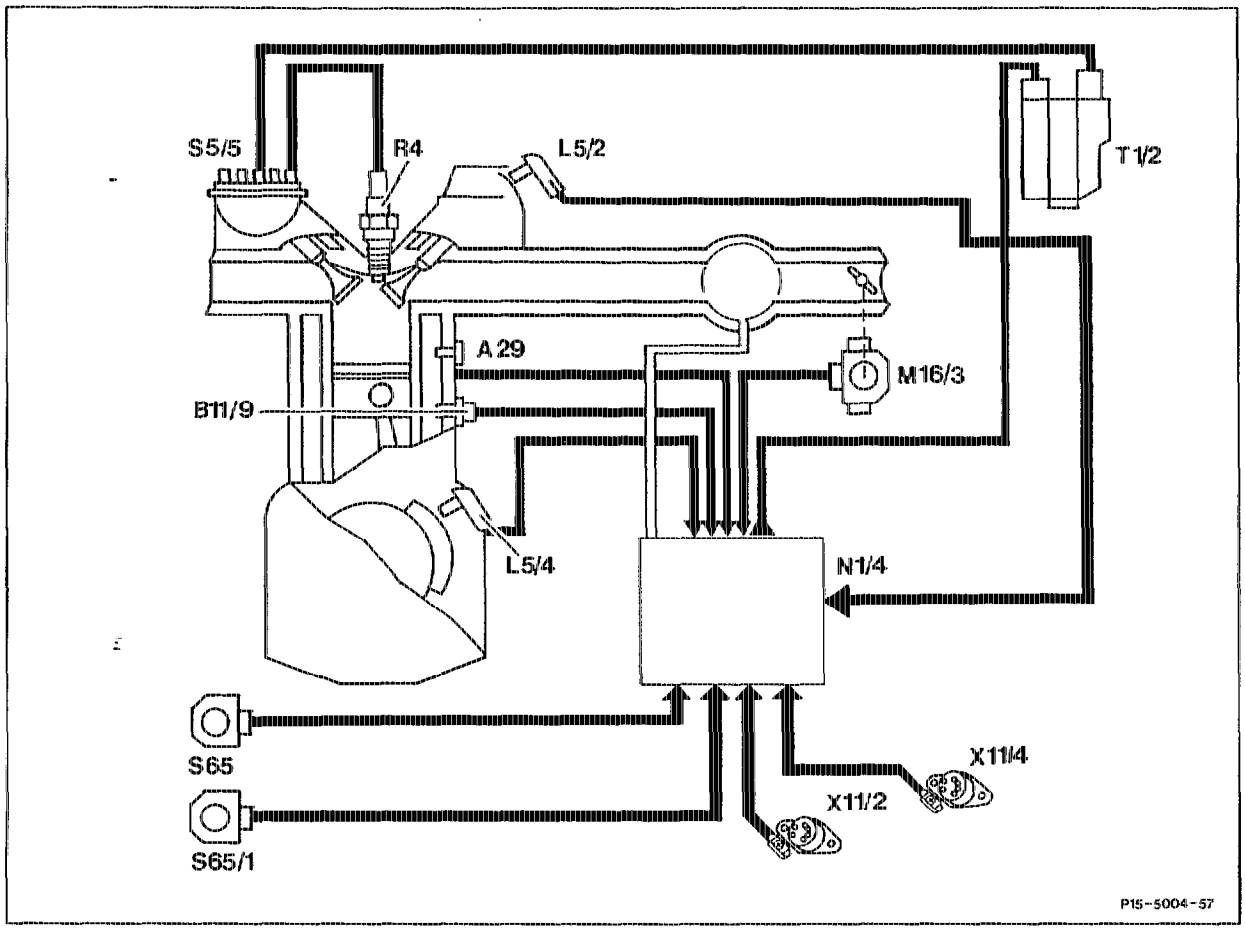
b) Engine 119



Example, left bank of cylinders

A16	Knock sensor	R4	Spark plugs
B11/2	Coolant temperature sensor	S5/4	High voltage distributor with position sensor
L5	Crankshaft position sensor	S65	Transmission overload protection switch, brake band B1
L5/1	Camshaft position sensor		
M16/1	Electronic accelerator pedal (EFP) actuator	T1/2	Ignition coil 2 (left bank of cylinders)
N1/3	EZL ignition control unit	X11	Diagnostic socket, 9-pin

c) Engine 120

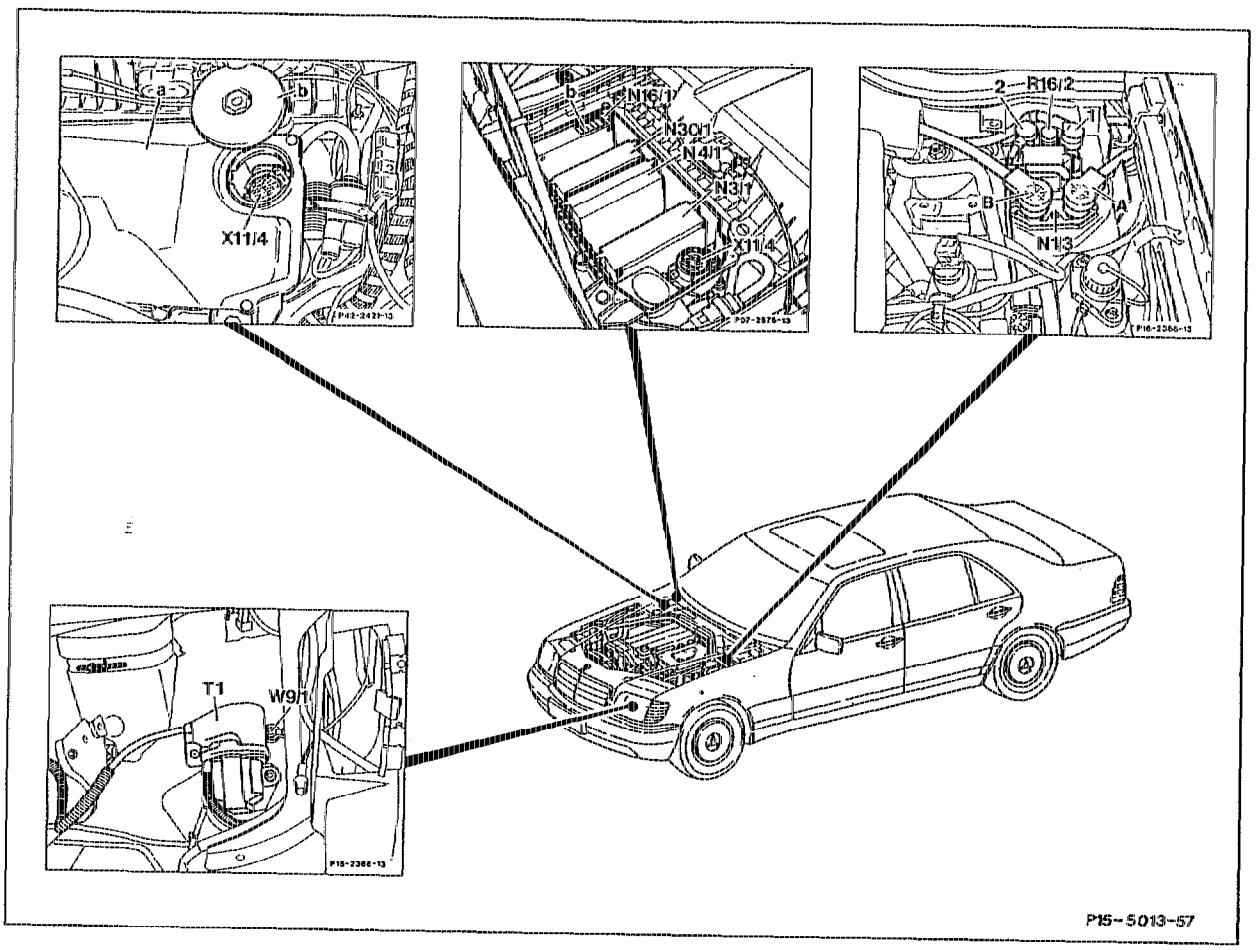


Example, left bank of cylinders

A29	Left knock sensor
B11/9	Left coolant temperature sensor
L5/2	Left camshaft position sensor
L5/4	Left crankshaft position sensor
M16/3	Electronic accelerator pedal (EFP) actuator
N1/4	Left EZL ignition control unit, hot wire (LH)
R4	Spark plugs
S5/5	Left high voltage distributor
S65	Transmission overload protection switch, brake band B1
S65/1	Transmission overload protection switch, brake band B2
T1/2	Ignition coil 2 (left bank of cylinders)
X11/2	Left diagnostic socket, 9-pin
X11/4	Test coupling for diagnosis, pulse signal (38-pin)

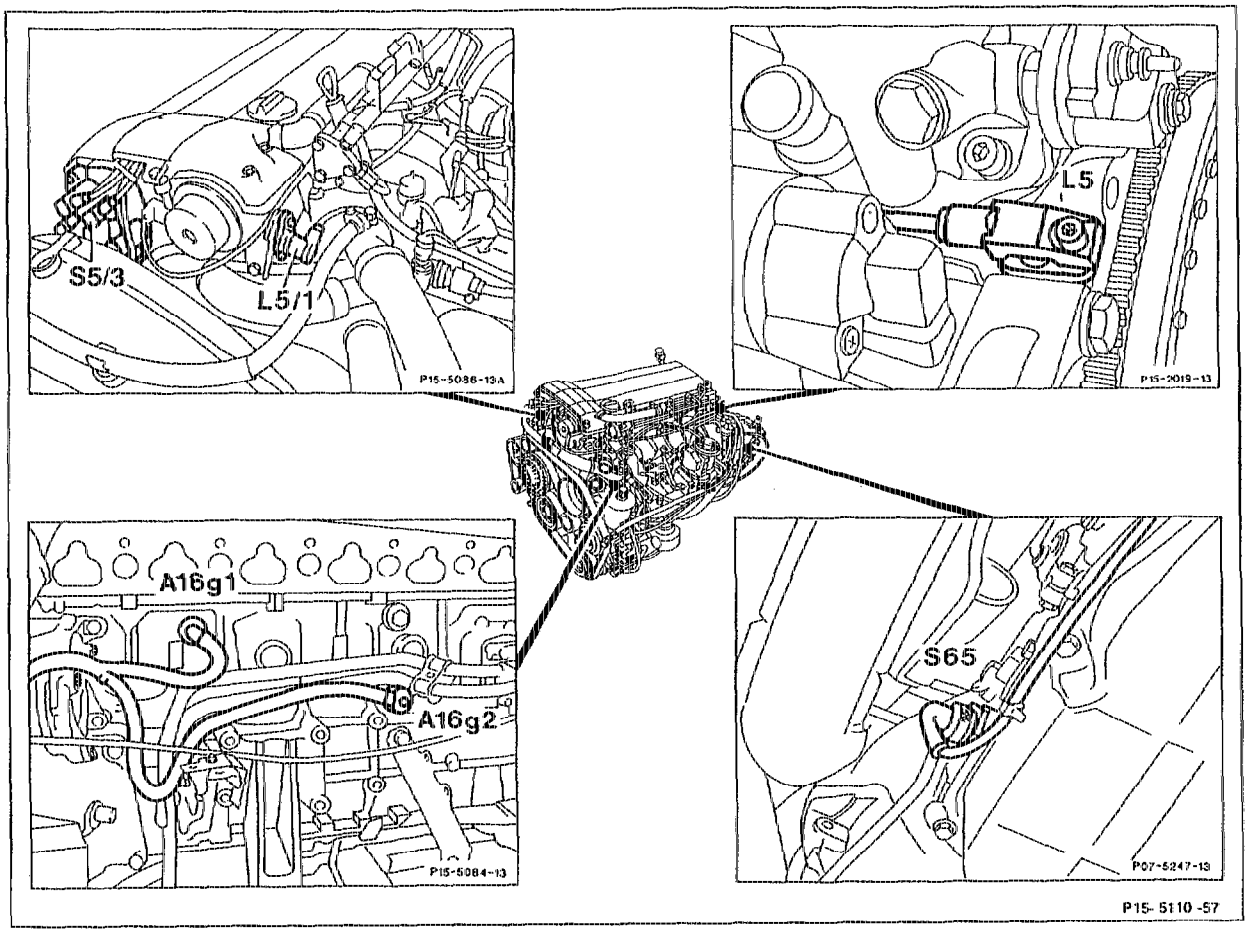
B. Location of components

a) Engine 104



Components in engine compartment

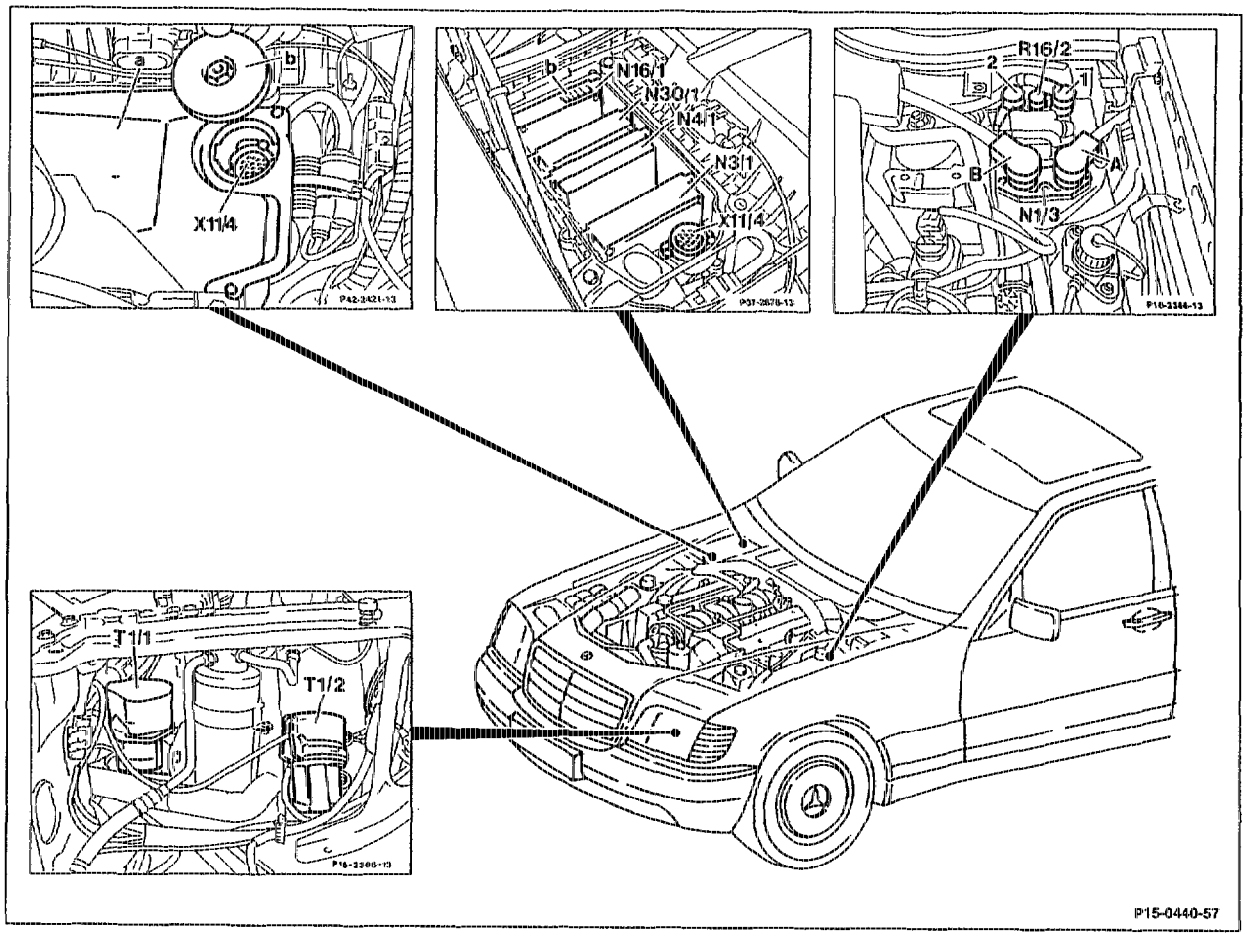
N1/3	EZL ignition control unit	R16/2	EZL resistance trimming coupling
N3/1	Hot wire (LH) control unit	T1	Ignition coil
N4/1	Electronic accelerator pedal (EFP) control unit	X11/4	Test coupling for diagnosis, pulse signal (38-pin)
N16/1	Base module (GM)		



Components on engine

A16g1	Knock sensor 1
A16g2	Knock sensor 2
L5	Crankshaft position sensor
L5/1	Camshaft position sensor
S5/3	High voltage distributor
S65	Transmission overload protection switch, brake band B1

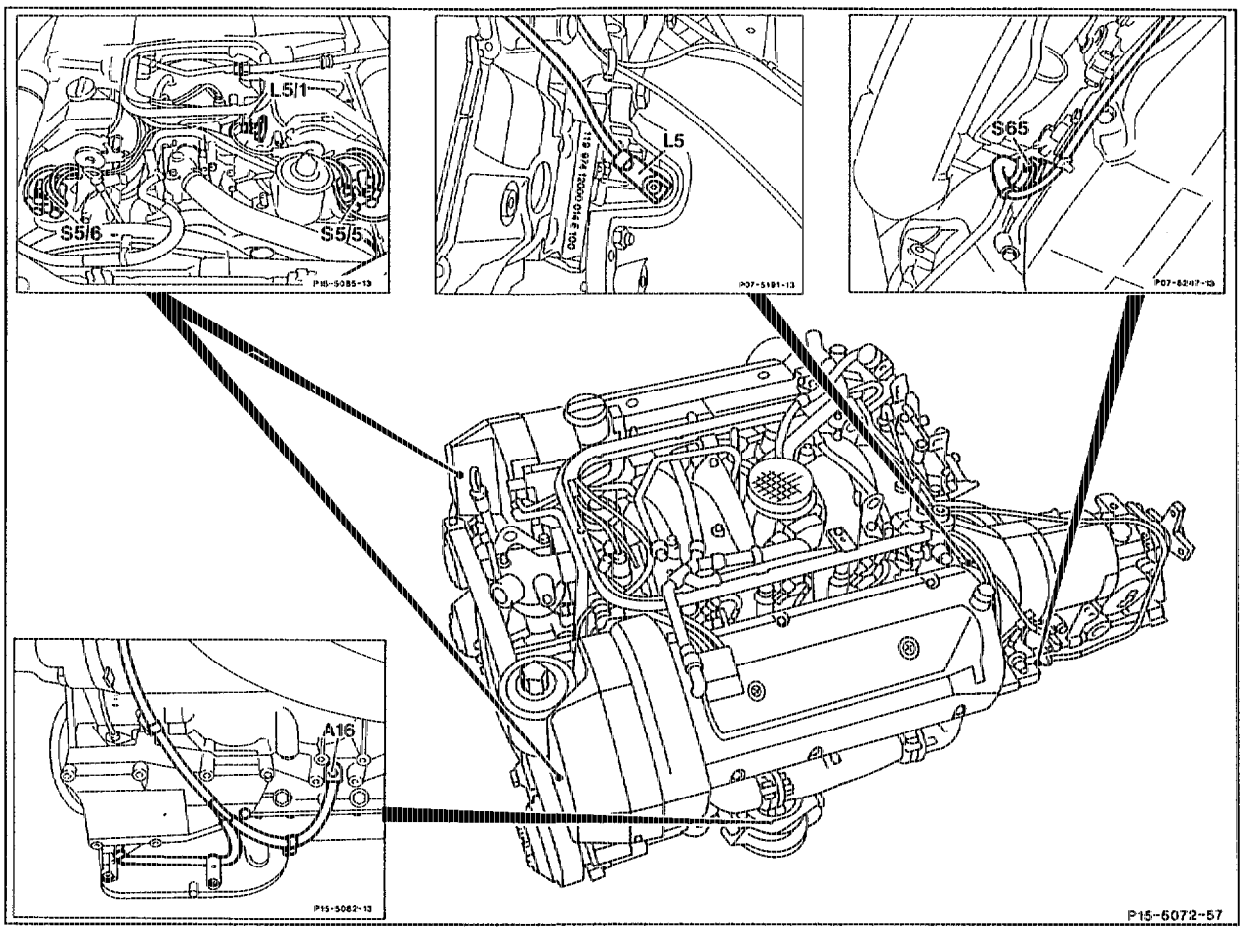
b) Engine 119



Shown on model 140

Components in engine compartment

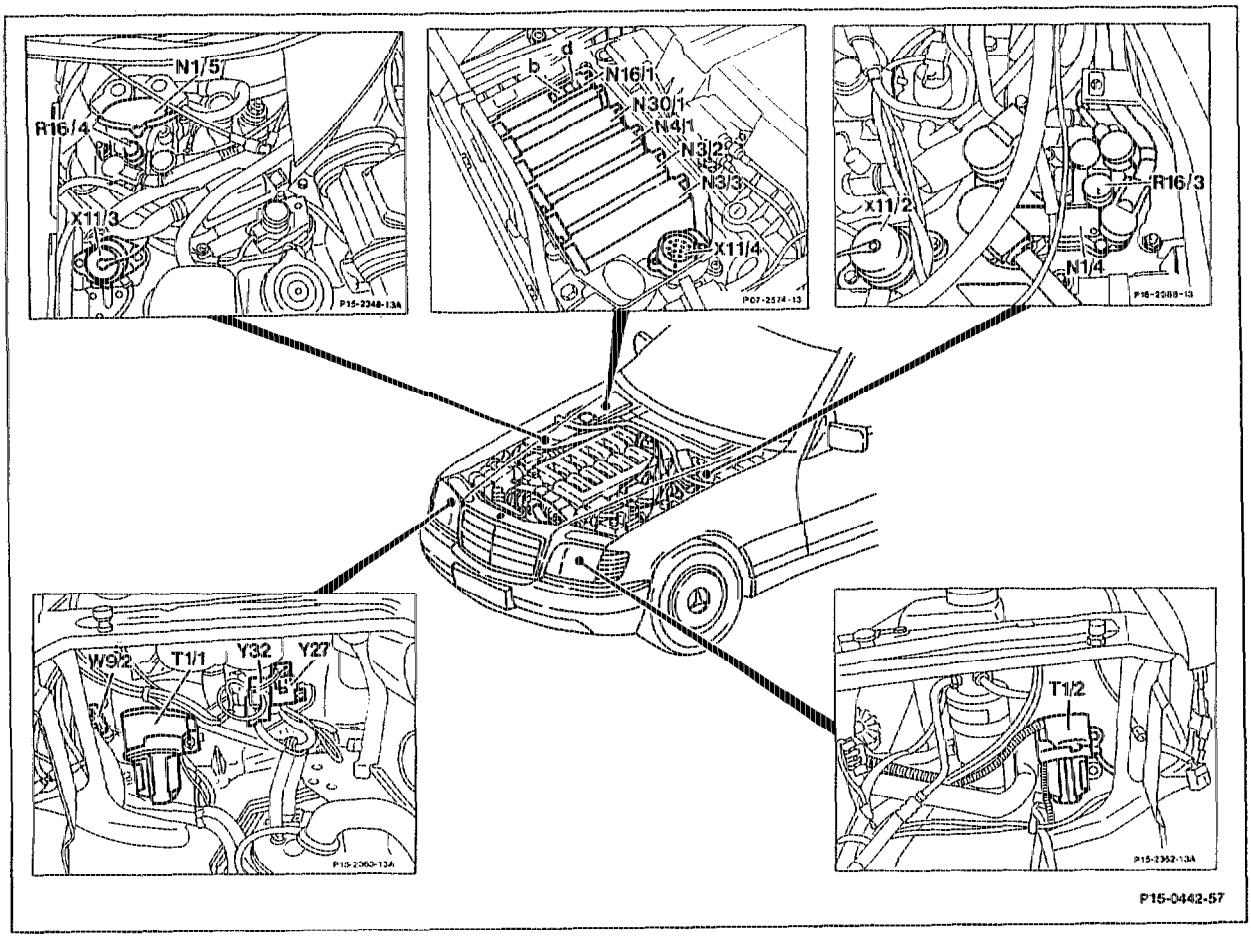
N1/3	EZL ignition control unit	R16/2	EZL resistance trimming coupling
N3/1	Hot wire (LH) control unit	T1/1	Ignition coil 1 (right bank of cylinders)
N4/1	Electronic accelerator pedal (EFP) control unit	T1/2	Ignition coil 2 (left bank of cylinders)
N16/1	Base module (GM)	X11/4	Test coupling for diagnosis, pulse signal (38-pin)
N30/1	ABS/ASR control unit		



Components on engine

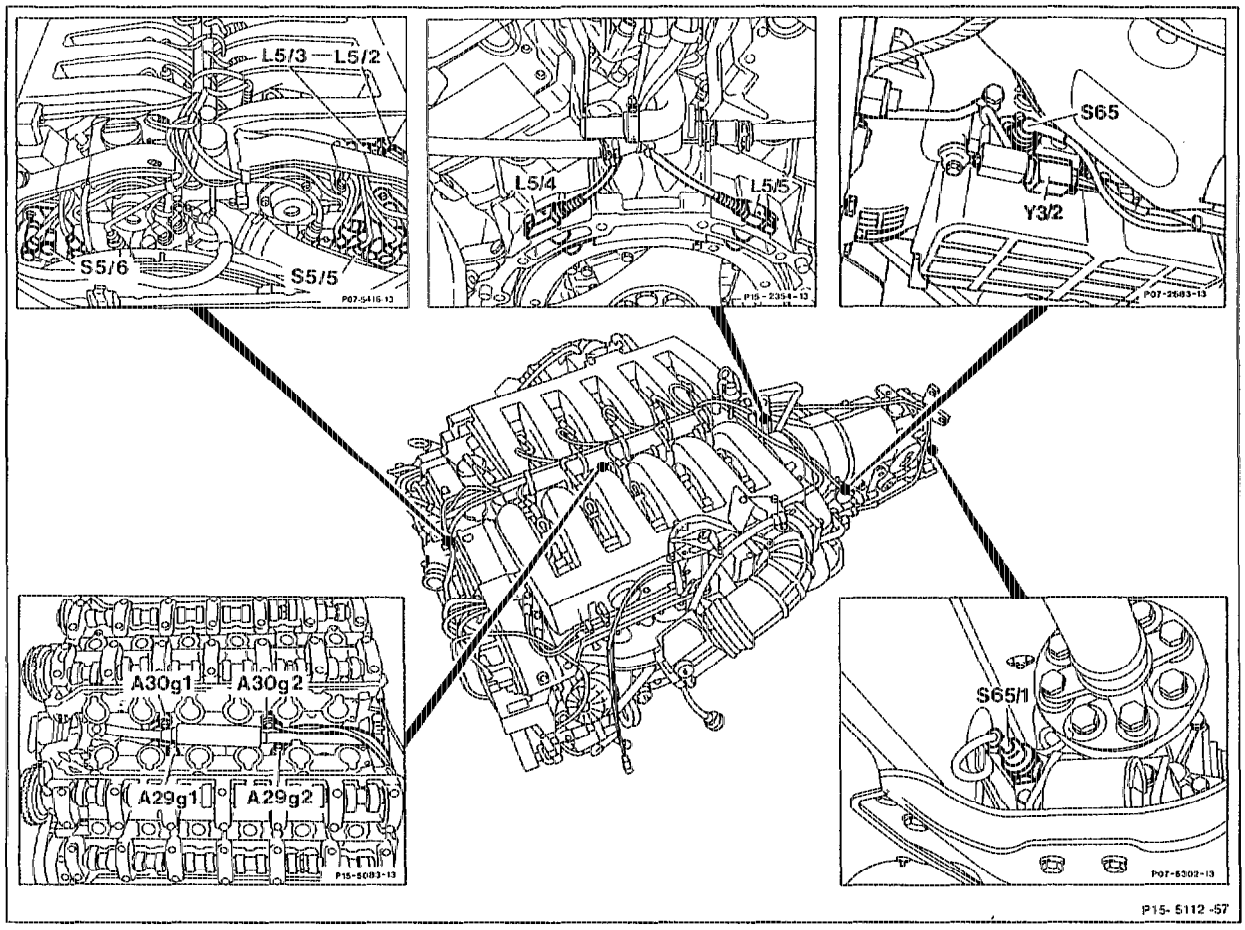
A16	Knock sensor	S5/5	Left high voltage distributor
L5	Crankshaft position sensor	S5/6	Right high voltage distributor
L5/1	Camshaft position sensor	S65	Transmission overload protection switch, brake band B1

c) Engine 120



Components in engine compartment

N1/4	Left EZL ignition control unit, hot wire (LH)
N1/5	Right EZL ignition control unit, hot wire (LH)
N3/2	Left hot wire (LH) control unit
N3/3	Right hot wire (LH) control unit
R16/3	Left EZL resistance trimming coupling
R16/4	Right EZL resistance trimming coupling
T1/1	Right ignition coil
T1/2	Left ignition coil
X11/2	Left diagnostic socket, 9-pin
X11/3	Right diagnostic socket, 9-pin
X11/4	Test coupling for diagnosis, pulse signal (38-pin)

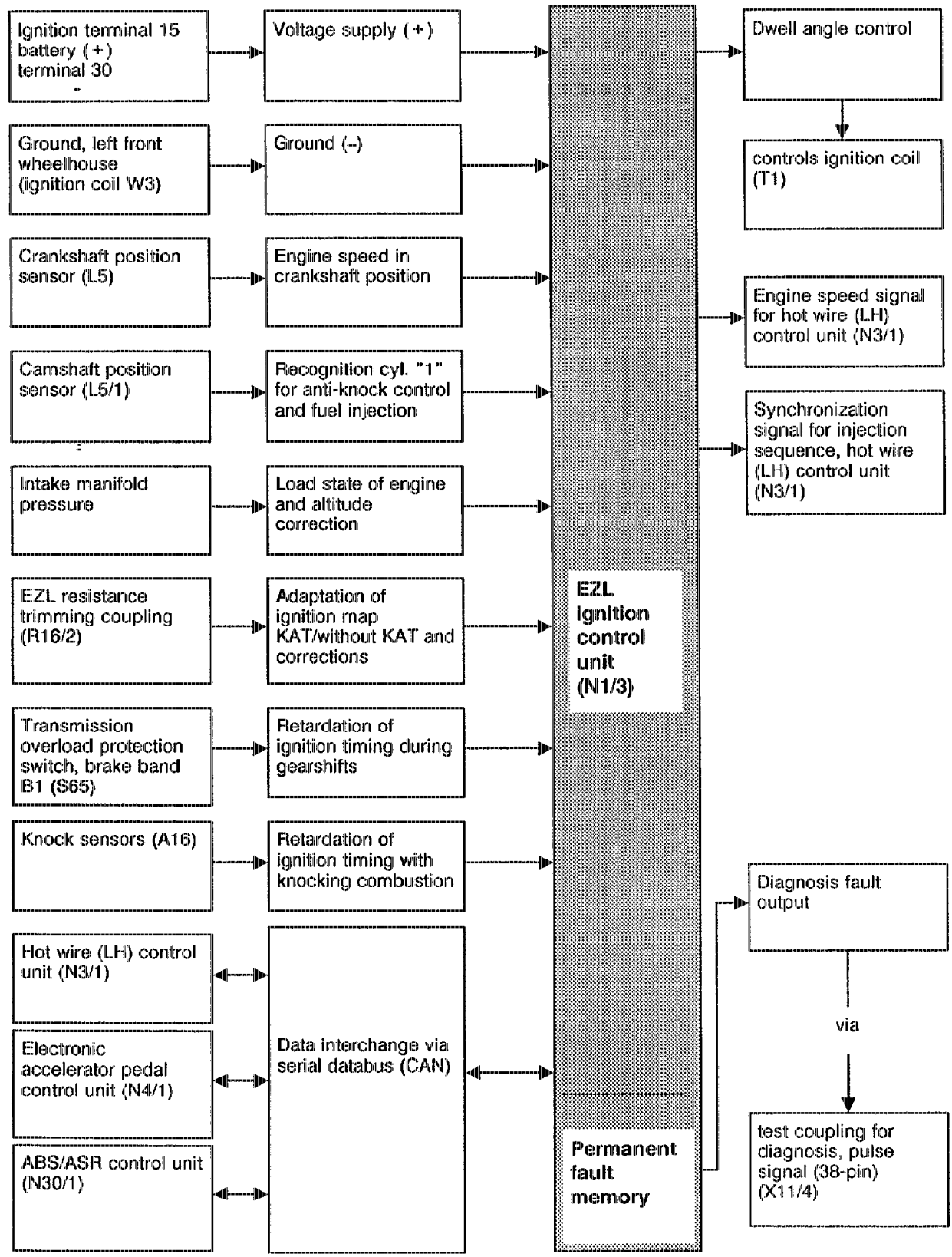


Components on engine

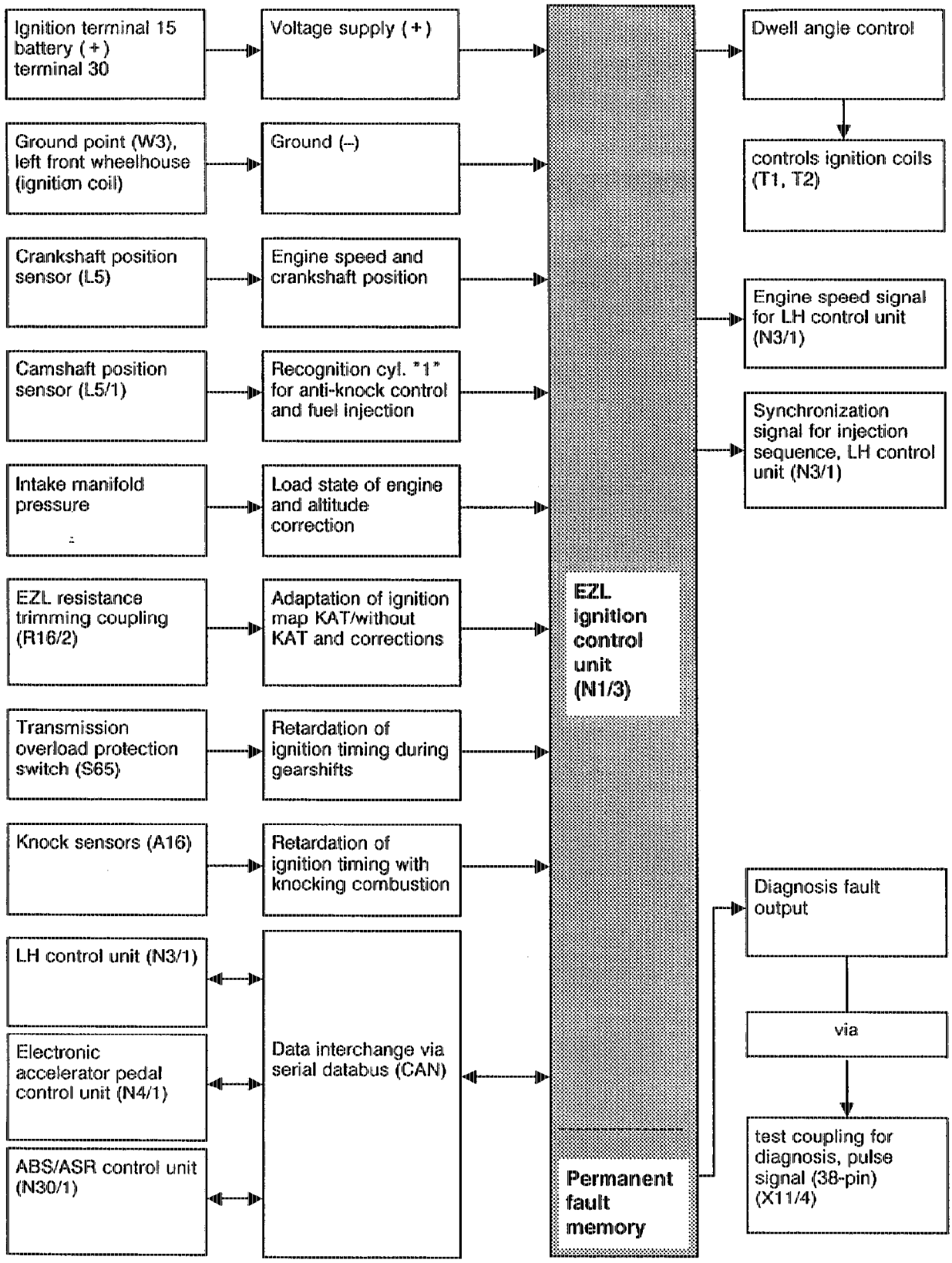
A29g1	Left knock sensors 1
A29g2	Left knock sensors 2
A30g1	Right knock sensors 1
A30g2	Right knock sensors 2
L5/2	Left camshaft position sensor
L5/3	Right camshaft position sensor
L5/4	Left crankshaft position sensor
L5/5	Right crankshaft position sensor
S5/5	Left high voltage distributor
S5/6	Right high voltage distributor
S65	Transmission overload protection switch, brake band B1
S65/1	Transmission overload protection switch, brake band B2

C. EZL block diagrams

a) Engine 104

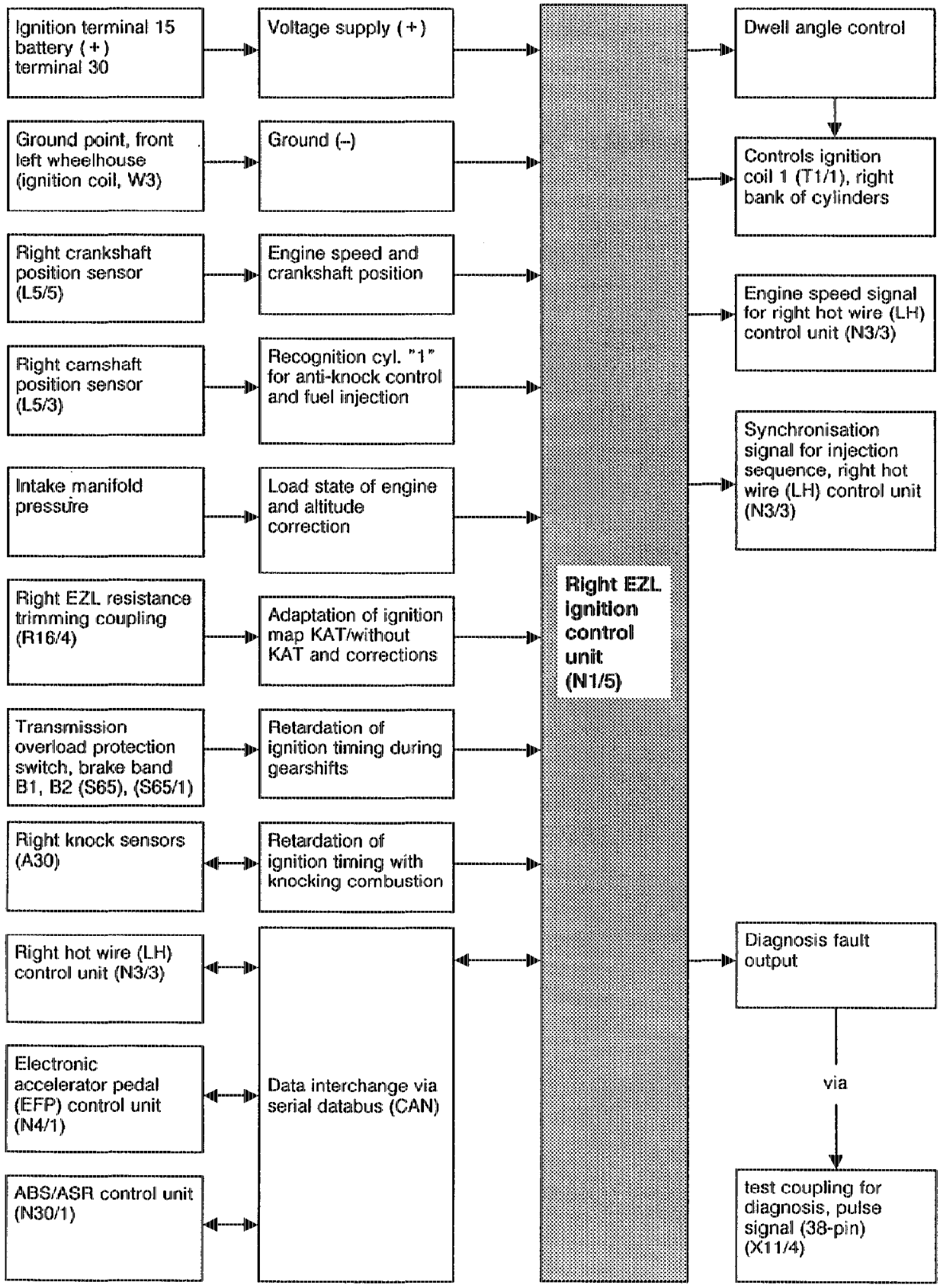


b) Engine 119

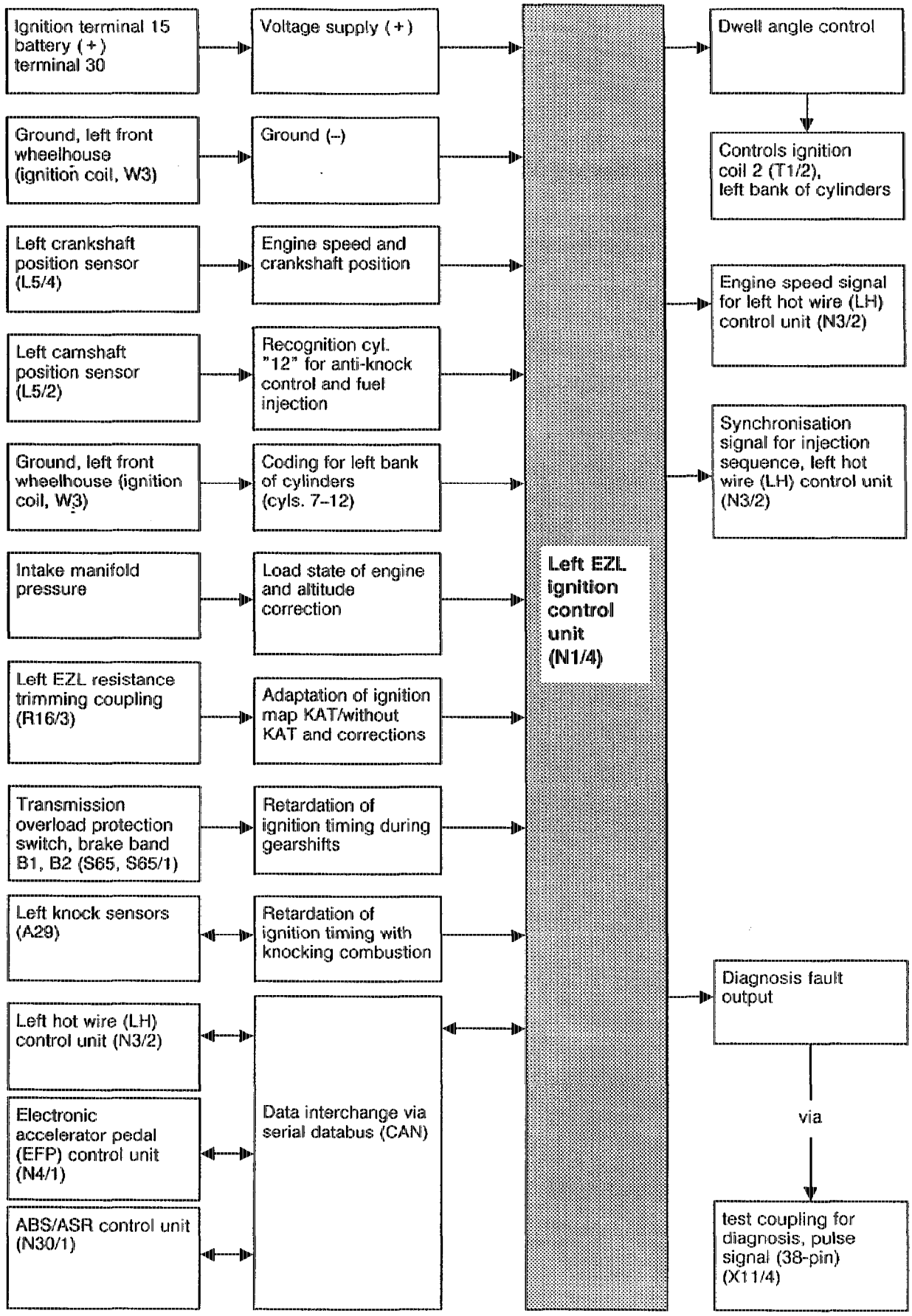

Ignition terminal 15 battery (+) terminal 30
Voltage supply (+)
Ground point (W3), left front wheelhouse (ignition coil)
Ground (–)
Crankshaft position sensor (L5)
Engine speed and crankshaft position
Camshaft position sensor (L5/1)
Recognition cyl. "1" for anti-knock control and fuel injection
Intake manifold pressure
Load state of engine and altitude correction
EZL resistance trimming coupling (R16/2)
Adaptation of ignition map KAT/without KAT and corrections
Transmission overload protection switch (S65)
Retardation of ignition timing during gearshifts
Knock sensors (A16)
Retardation of ignition timing with knocking combustion
LH control unit (N3/1)
Electronic accelerator pedal control unit (N4/1)
ABS/ASR control unit (N30/1)
Data interchange via serial databus (CAN)
EZL ignition control unit (N1/3)
Permanent fault memory
Dwell angle control
controls ignition coils (T1, T2)
Engine speed signal for LH control unit (N3/1)
Synchronization signal for injection sequence, LH control unit (N3/1)
Diagnosis fault output
via
test coupling for diagnosis, pulse signal (38-pin) (X11/4)

c) Engine 120

Right bank of cylinders



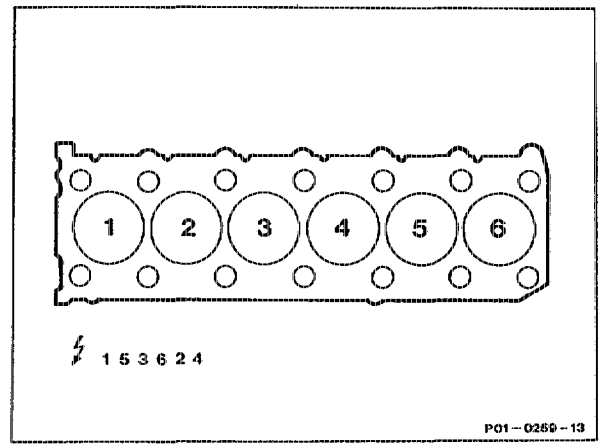
Left bank of cylinders



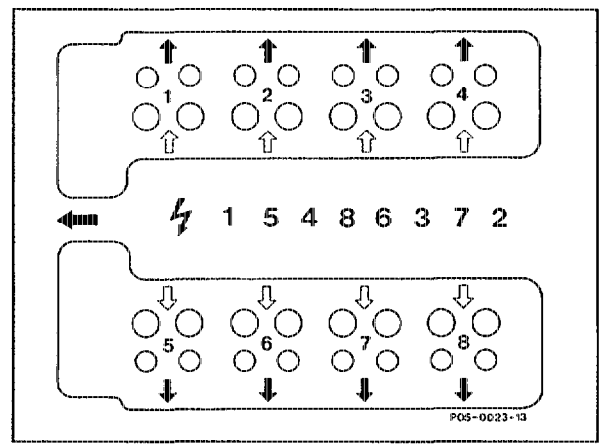
D. Ignition coil

In engine 104 one, in engines 119 and 120 one ignition coil for each of the two banks of cylinders, is used, with a separate ignition system being used in engine 120 for each bank of cylinders.
Location, see Section "B".

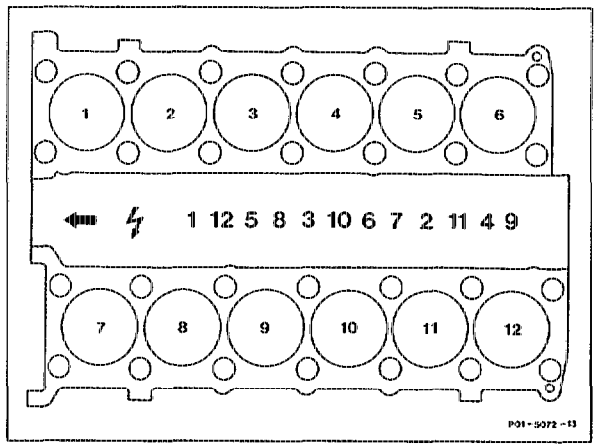
E. Firing order



Engine 104



Engine 119



F. EZL ignition control unit

a) General

An ignition map for vehicles with catalytic converter and an ignition map for vehicles without catalytic converter is stored in the EZL ignition control unit (N1/3, engine 120 N1/4 and N1/5).

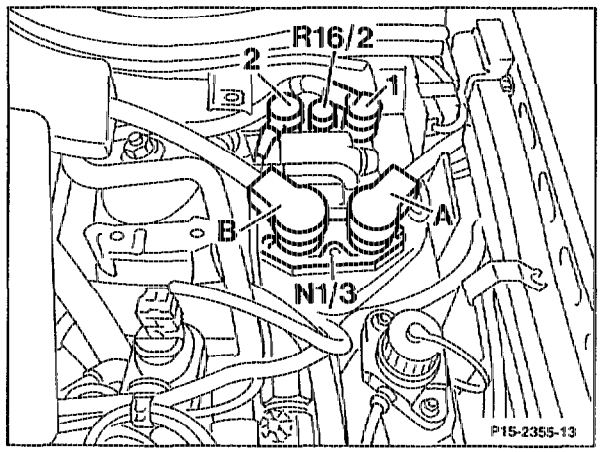
Faults which occur when the engine is running are counted by a fault counter.

Only if a fault occurs during more than 8 successive trips it is entered into the fault memory after the engine is switched off and can be read with the pulse counter.

If the fault then no longer occurs, it is erased again after a certain number of starts.

Only faults which prevent the engine from 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 test coupling for diagnosis (X11/4) (see Diagnosis Manual Engine Volume 2).



⚠

The fault memory should be read when the engine is not running and the ignition is switched on.

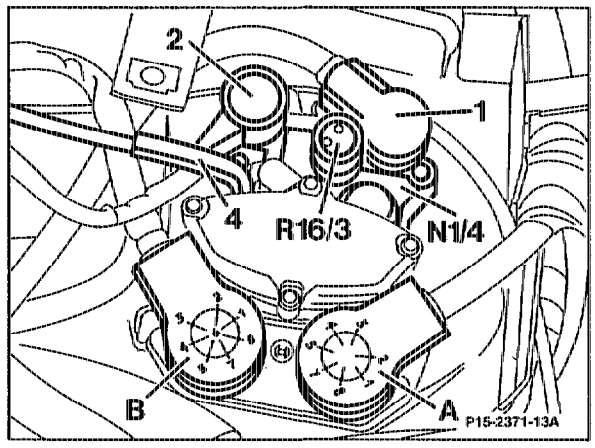
The idle speed and full load signals are passed by the actuator at the throttle valve via the electronic accelerator pedal control unit (N4/1) or idle speed control/Tempomat control unit (N4/3), depending on the equipment, to the EZL ignition control unit.

b) Assignment of ignition control units (engine 120)

The assignment (coding) of the two ignition control units to the corresponding bank of cylinders is performed via coupling "A" contact "6".

If contact "6" is not assigned, this ignition control unit is assigned to the right bank of cylinders (cylinders 1–6), viewed in direction of travel.

If ground exists at contact "6", this ignition control unit is assigned to the left bank of cylinders (cylinders 7–12).



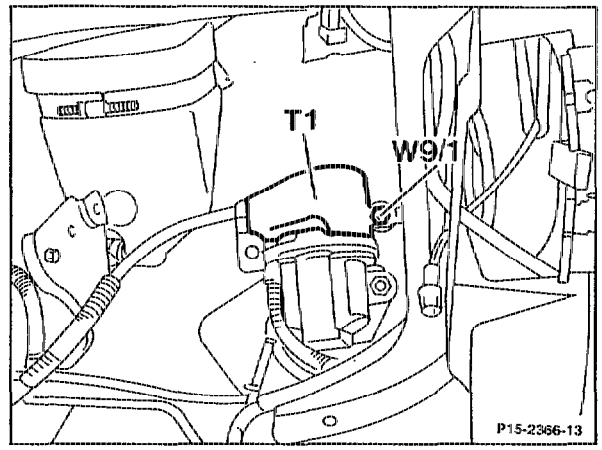
Shown on left EZL ignition control unit (N1/4)

c) Assignment of couplings

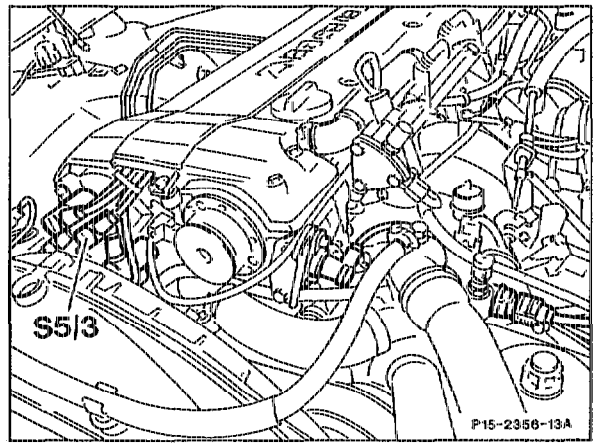
	Engine 104	Engine 119	Engine 120
1	3-pin coupling knock sensors: 1 Common ground 2 Knock sensor 1 3 - Knock sensor 2	3-pin coupling knock sensors: 1 Common ground 2 Knock sensor 1 (left side of engine) 3 Knock sensor 2 (right side of engine)	3-pin coupling knock sensors: 1 Common ground 2 Knock sensor 1 (left side of engine) 3 Knock sensor 2 (right side of engine)
2	Coaxial connector for control cable from crankshaft position sensor	Coaxial connector for control cable from crankshaft position sensor	Coaxial connector for control cable from crankshaft position sensor
3	EZL resistance trimming coupling (R16/2)	EZL resistance trimming coupling (R16/2)	Left EZL resistance trimming coupling (R16/3) Right EZL resistance trimming coupling (R16/4)
4	Vacuum connection	Vacuum connection	Vacuum connection
A	8-pin coupling: 1 Ignition coil (T1) terminal 1 2 Ground terminal 31 3 Terminal 15 4 TN signal 5 Negative, position sensor/ cylinder recognition 6 Vacant 7 Pulse output 8 Camshaft position sensor (L5/1) signal output	8-pin coupling: 1 Ignition coil (T1/2) terminal 1 2 Ground terminal 31 3 Terminal 15 4 TN signal 5 Negative, position sensor/ cylinder recognition 6 Ignition coil (T1/1) terminal 1 7 Pulse output 8 Camshaft position sensor (L5/1) signal output	8-pin coupling: 1 Ignition coil (T1/1, T1/2) terminal 1 2 Ground terminal 31 3 Terminal 15 4 TN signal 5 Negative, TN signal/ cylinder recognition/ diagnostic output 6 left: ground (coding for left bank of cylinders, cylinders 7–12), right: vacant 7 Pulse output and serial diagnosis interface 8 Camshaft position sensors (L5/2, L5/3) signal output
B	8-pin coupling: 1 Camshaft position sensor (L5/1) signal input 2 Transmission overload protection 3 Data line 4 Data line 5 Ground, camshaft position sensor 6 Ground, data line 7 Vacant 8 Terminal 30	8-pin coupling: 1 Camshaft position sensor (L5/1) signal input 2 Transmission overload protection 3 Data line 4 Data line 5 Ground, camshaft position sensor 6 Ground, data line 7 Vacant 8 Terminal 30	8-pin coupling: 1 Camshaft position sensors (L5/2, L5/3) signal input 2 Transmission overload protection 3 Data line 4 Data line 5 Ground, camshaft position sensor 6 Ground, data line 7 Vacant 8 Terminal 30

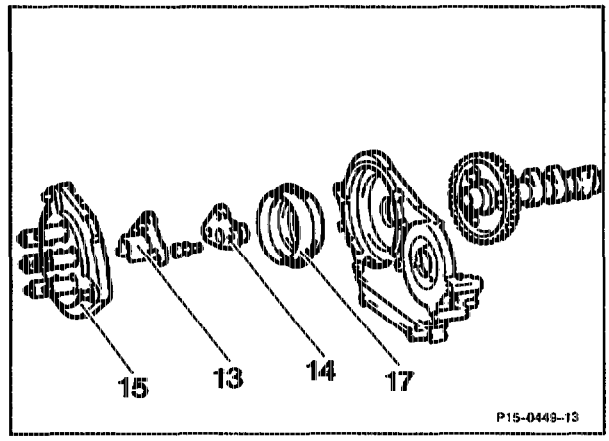
Engine 104

The EZL ignition control unit features a power output stage which actuates an 11 A ignition coil (T1).



The high voltage is distributed through the high voltage distributor (S5/3) in the firing order 1–5–3–6–2–4.
The moving carbon in the distributor has been replaced by a fixed central electrode.

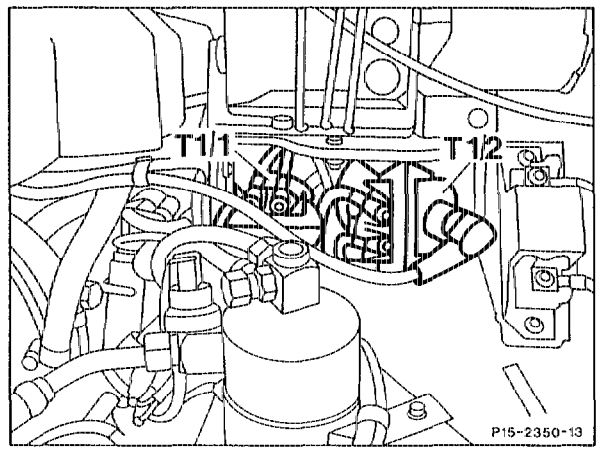




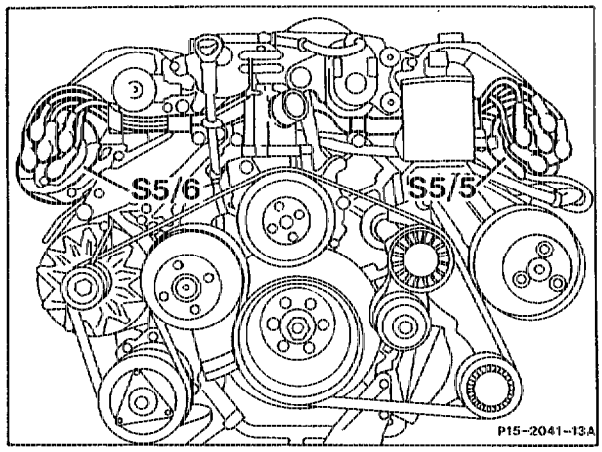
13 Distributor rotor arm
14 Follower
15 Distributor cap
17 Cover

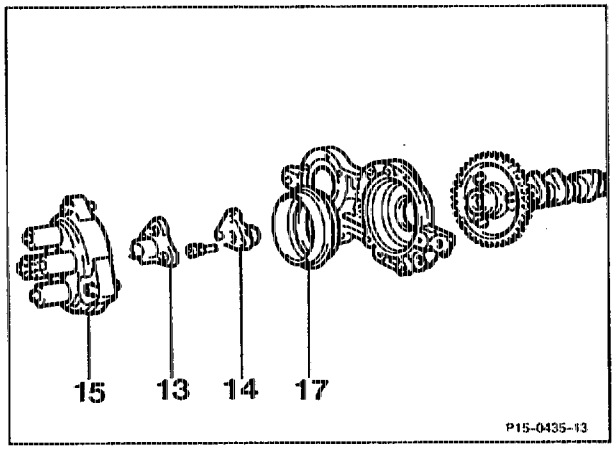
Engine 119

The EZL ignition control unit features two separate power output stages each of which actuates an 11 A ignition coil (T1/1, T1/2).



The high voltage is likewise distributed through two separate high voltage distributors (S5/5, S5/6).
The high voltage distributor (S5/6) distributes the high voltage to cylinders 1, 4, 6 and 7, the high voltage distributor (S5/5) to cylinders 5, 8, 3 and 2.
The moving carbon in the high voltage distributor has been replaced by a fixed central electrode.

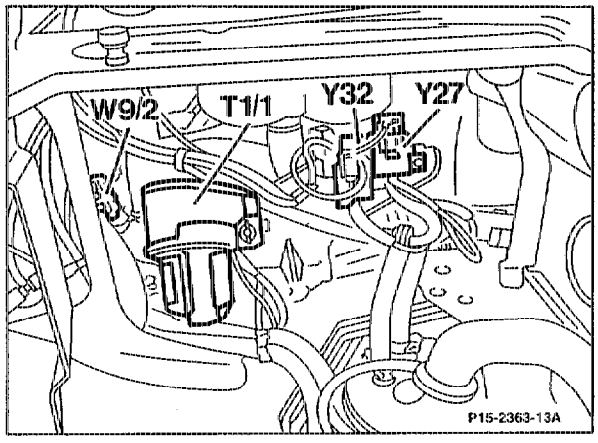




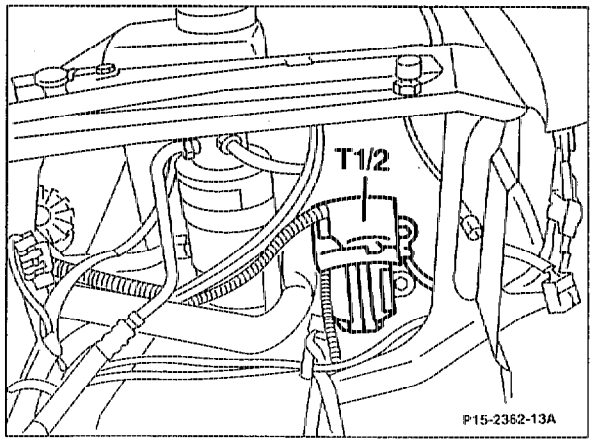
13 Distributor rotor arm
14 Follower
15 Distributor cap
17 Cover

Engine 120

The EZL ignition control units each feature a power output stage which actuate an 11 A ignition coil (T1/1, T1/2).

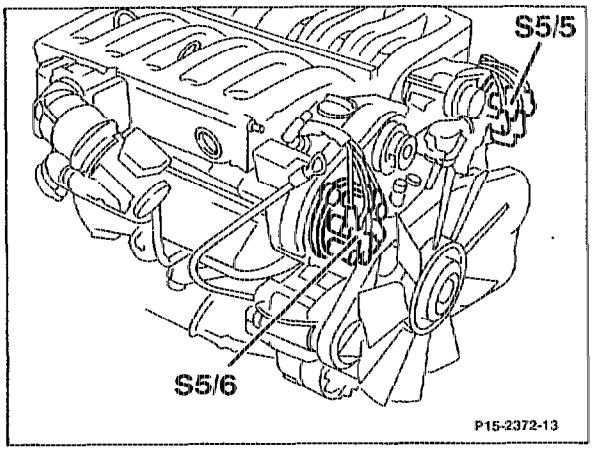


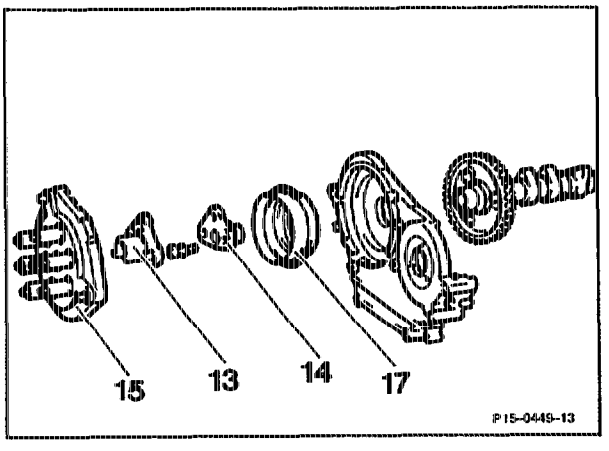
T1/1 Ignition coil 1 (right bank of cylinders)



T1/2 Ignition coil 2 (right bank of cylinders)

The high voltage is distributed through two separate high voltage distributors (S5/5, S5/6). The high voltage distributor (S5/5) distributes the high voltage to the left bank of cylinders (cylinders 7–12) in the firing order 12–8–10–7–11–9, the high voltage distributor (S5/6) to the right bank of cylinders (cylinders 1–6) in the firing order 1–5–3–6–2–4.
The moving carbon in the high voltage distributor has been replaced by a fixed central electrode.

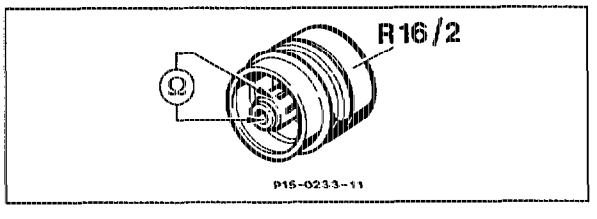




13 Distributor rotor arm
14 Follower
15 Distributor cap
17 Cover

d) EZL resistance trimming coupling

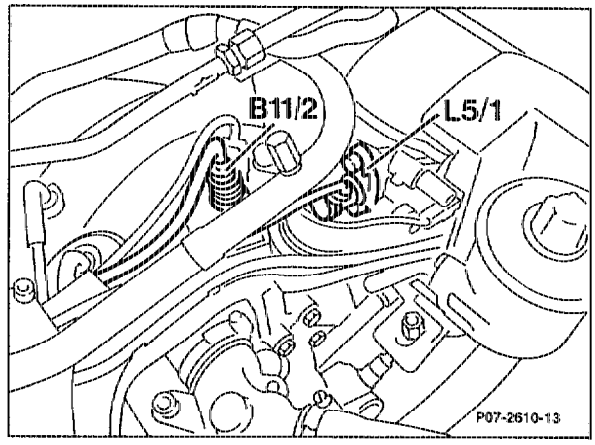
The ignition map for KAT or without KAT is activated via the resistance trimming coupling (R16/2, engine 120 R16/3 and R16/4).
The ignition is set for unleaded premium grade fuel with an octane rating of RON 95.
If regular grade fuel with e. g. an octane rating of RON 91 is used, a suitable resistance trimming coupling (R16/2, engine 120 R16/3 and R16/4) must be installed (see Diagnosis Manual Engine, Volume 1).



Note
If regular grade fuel is used, the ignition timing is retarded by the anti-knock control which increases the overall temperature level of the engine. For this reason, regular grade fuel should only be used if, in exceptional cases, no premium unleaded or premium plus is available (see also Owner's Manual).

e) TN signal
The EZL ignition control unit converts the sinusoidal signal of the crankshaft position sensor into a square wave signal – TN signal. The conversion to the TN signal has become necessary as the ignition timing for each cylinder in the kriock control range may differ. The TN signal can be measured in exactly the same way as the TD signal.
The signal is passed by the EZL ignition control units to the respective LH control unit and from there to the base module.

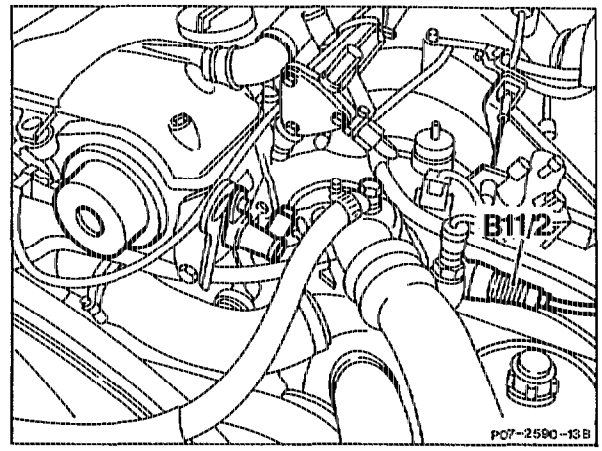
f) Synchronisation signal for fuel injection system
The injection sequence must be synchronized to ensure that the moment of injection is correctly matched to the respective cylinder. The signal of the camshaft position sensor (L5/1, engine 120 L5/2 and L5/3) is required for this purpose.
The camshaft position sensor generates two alternating voltage signals during 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.



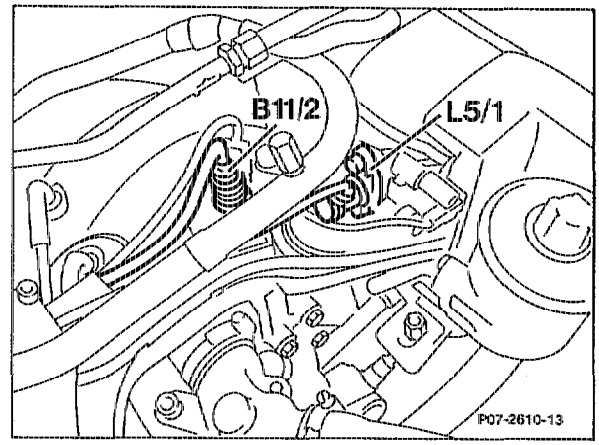
g) Coolant temperature signal

This signal is passed by the coolant temperature sensors (B11/2, engine 120 B11/9 and B11/10) to the respective LH control unit and from there via the CAN databus to the respective EZL ignition control unit.

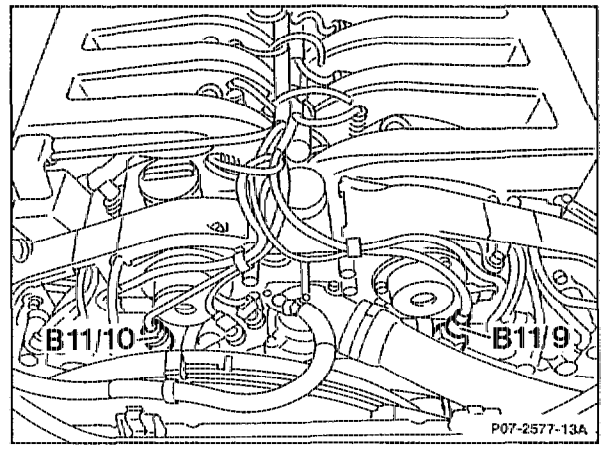
Engine 104



Engine 119



Engine 120



h) Safety measures

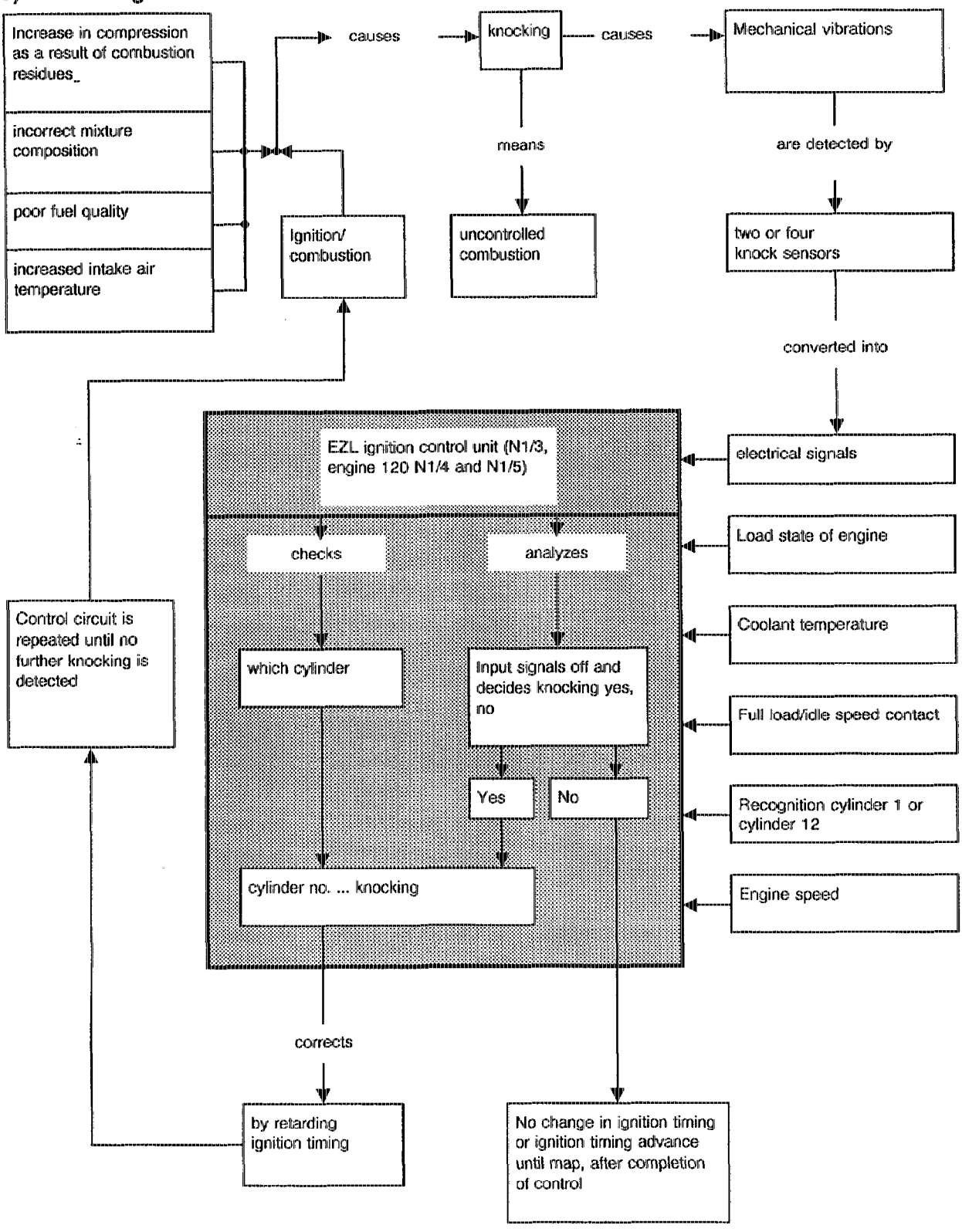
Should one of the coolant temperature sensors fail, a substitute temperature of 120 °C is selected. As this temperature is within the boiling protection range, the ignition timing advance is retarded by 3.5° CA.

Should the load sensor in the EZL ignition control unit fail, full load is assumed to thus activate the anti-knock control.

Should the knock sensors, the analysis circuit in the EZL ignition control unit and/or the camshaft sensor fail, ignition timing is retarded 10° CA as a safety measure.

G. Anti-knock control (AKR)

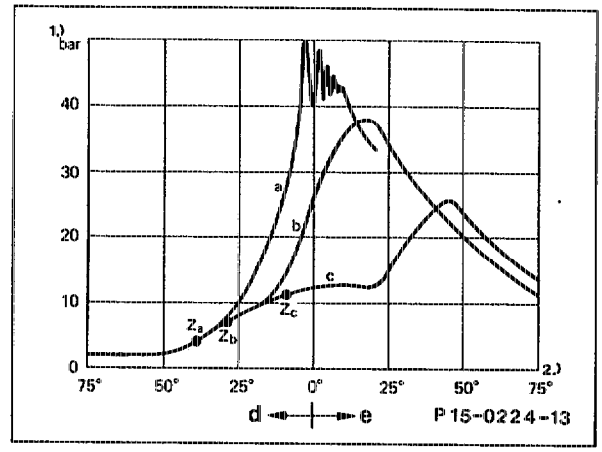
a) Block diagram



b) Function

The ignition maps of the ignition system (EZL) are designed for optimal engine output. Should knocking combustion occur under certain operating conditions, the knocking cylinder is detected in the respective EZL ignition control unit by the integrated anti-knock control and ignition timing is retarded accordingly.

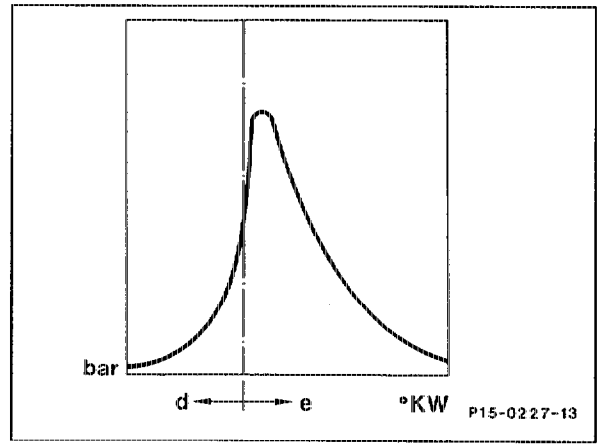
Knocking combustion may occur, for example, as a result of poor fuel quality and deposits in the combustion chambers.
The anti-knock control has been developed to avoid damage as a result of knocking combustion. The anti-knock control is integrated in the EZL ignition control unit.



1.) Pressure in combustion chamber
2.) Ignition advance angle

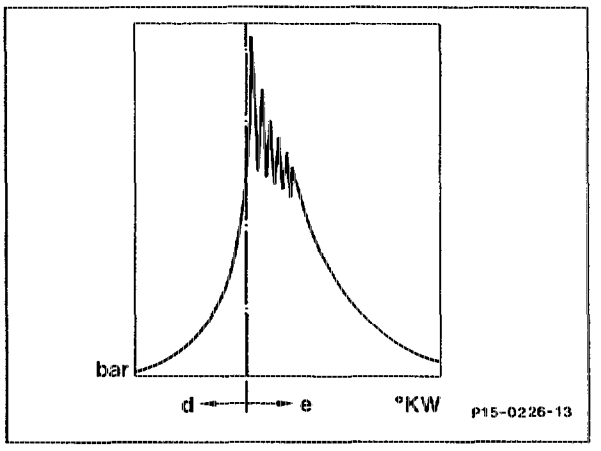
a Ignition excessively advanced – knocking
b Ignition timing correct
c Ignition excessively retarded
d BTDC
e ATDC

Pressure curve in combustion chamber during normal combustion



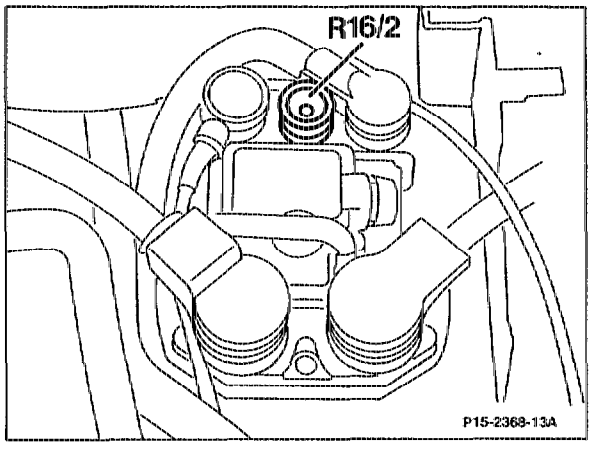
d BTDC
e ATDC

Pressure curve in combustion chamber during knocking combustion



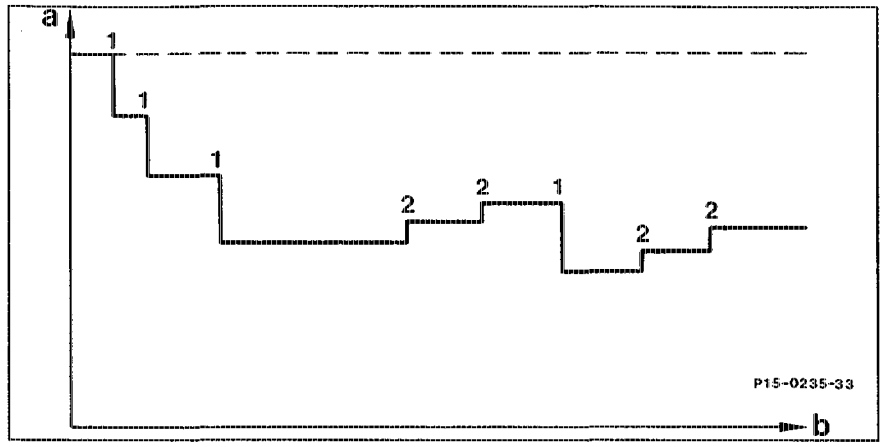
d BTDC
e ATDC

The "KAT" or "without KAT" ignition map in the EZL ignition control unit is activated by fitting on an appropriate resistance trimming coupling (R16/2, engine 120 R16/3 and R16/4).
Should knocking combustion occur as a result, e. g. of fuel with a low octane number, the mechanical vibrations produced are converted in the knock sensors into electrical signals and passed to the respective EZL ignition control unit.
The EZL ignition control unit compares these incoming signals with the specifications stored in the integrated microcomputer.
If deviations exist, the ignition timing for the cylinder in which knocking combustion has taken place is retarded by 3° CA as early as the next ignition.
Should the cylinder continue to knock, ignition timing is retarded by a further 3° CA.
This retardation of ignition timing may be repeated if knocking combustion continues to exist until a maximum retardation is reached, this being dependent on coolant temperature (e. g. 12 ° CA at 80–90 °C coolant temperature).



Shown on engine 119

Several knocking combustions in a cylinder



1 Ignition angle retarded by 3° CA
2 Ignition angle advanced by 0.35° CA

a Ignition angle BTDC
b Power strokes

Should no further knocking combustion occur, the ignition timing of the cylinder in question is restored to the map value by being advanced 0.35° CA per ignition.

An additional signal is required for detecting the cylinders for the anti-knock control. This alternating voltage signal comes from the camshaft position sensor (L5/1, engine 120 L5/2 and L5/3).
Engines 104 and 119 each have a camshaft position sensor (L5/1) which detects cylinder 1. Engine 120 has two camshaft position sensors (L5/2 and L5/3) which detect cylinders 1 and 7.

Should one of the following components fail, an ignition timing retardation dependent on coolant temperature is activated for all cylinders for safety reasons:

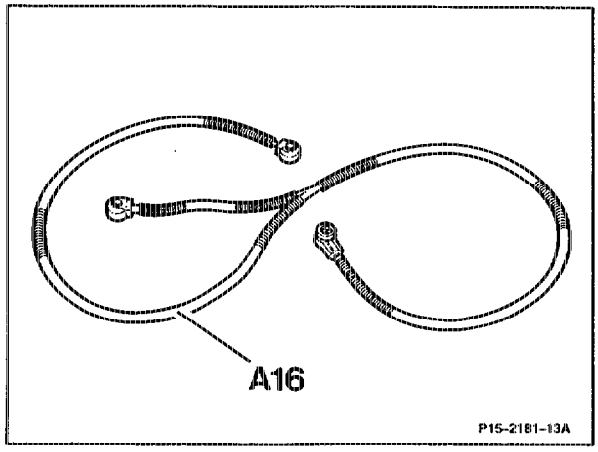
- Knock sensors,
- knock sensor analysis circuit of anti-knock control in EZL ignition control unit,
- camshaft position sensor (L5/1, engine 120 L5/2 and L5/3).

Examples for retardation of ignition timing dependent on coolant temperature:
10° CA at 100 °C coolant temperature
7° CA at 80 °C coolant temperature

To facilitate fault finding, faults at certain components can be interrogated by means of a pulse readout (flash code).

c) Knock sensor units

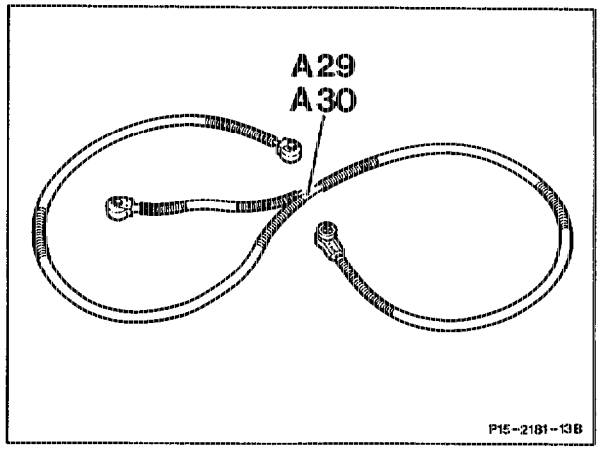
Piezo electric structure-borne sound sensors are used as knock sensors (A16, engine 120 A 29 and A30).
The vibrations of the engine block are transmitted to the piezo ceramic and passed in the form of an alternating voltage signal along a screened wire to the EZL ignition control unit.
A knock sensor unit consists of two knock sensors which are combined in a cable and can thus only be replaced as a unit.



Engine 104, 119
A16 Knock sensor unit

Note

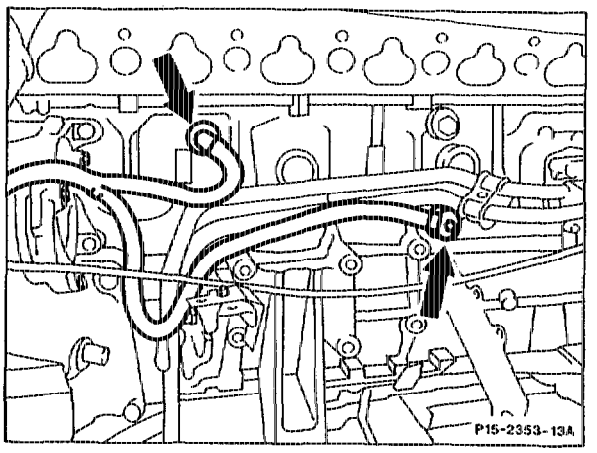
Piezo effect = generation of voltage as a result of pressure acting on a certain ceramic.



Engine 120
A29 Left knock sensor unit
A30 Right knock sensor unit

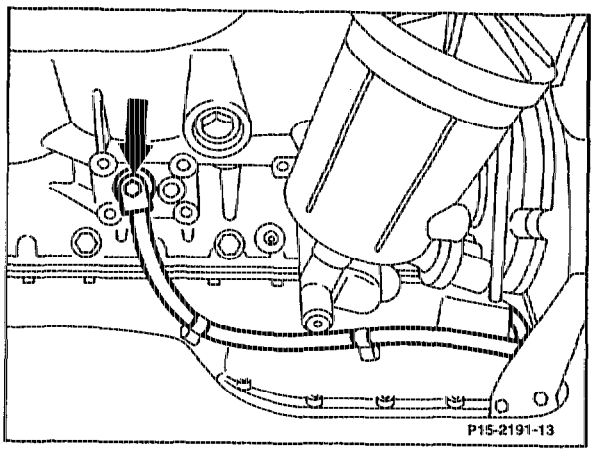
Engine 104

The knock sensors (arrows) are attached to the engine block below the intake manifold. This location point has been selected as it is the best location to detect knocking combustion at all cylinders.

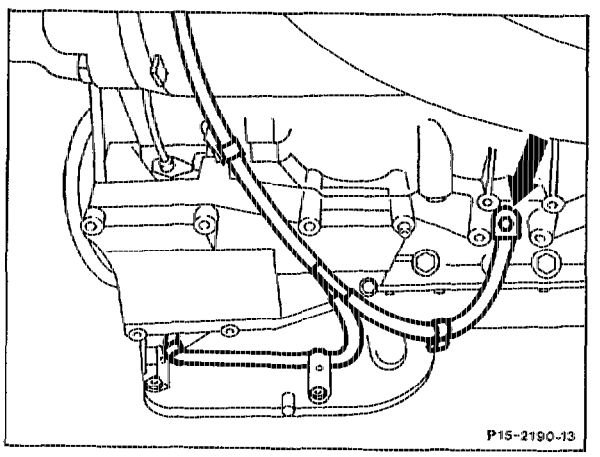


Engine 119

The knock sensors are attached to the engine block in each case below an engine carrier. This installation point has been selected as it is the best point to detect knocking combustion at all cylinders.



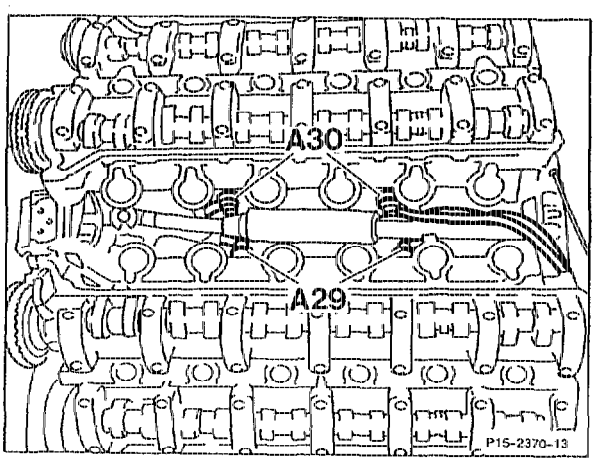
Arrow Knock sensor, right side of engine



Arrow Knock sensor, left side of engine

Engine 120

The knock sensors (A29) and (A30) are attached to the insides of the engine block between the banks of cylinders. This installation point has been selected as it is the best point to detect knocking combustion at all cylinders. The cables of the two knock sensors for each side of the engine are combined in a protective sheath (flexible sheath).



H. Camshaft position sensors

Two position pointers are arranged at the camshaft sprocket, offset relative to each other. This enables the cylinders to be detected during each revolution of the crankshaft for synchronisation of injection sequence as well as for the anti-knock control.
The injection sequence for the cylinders is synchronized during the starting operation. In order to obtain a strong signal already at starting speed, the air gap between position sensor and position pointer must only be 0.4–0.6 mm.
When performing repairs, the air gap must be checked and set, if necessary, with spacers (see repair instructions).

I. Catalytic converter heating up

The exhaust temperature is increased in order to heat up the catalytic converter more rapidly to its operating temperature.
For this purpose, the ignition timing, at idling speed and with selector lever in P or N, is continuously retarded at a coolant temperature between approx. +15 °C and +40 °C after each start for about 30 seconds depending on temperature, and idling speed is increased by the idle speed control to 1100–1200/min. The idle speed increase is deactivated once a Drive mode has been engaged.

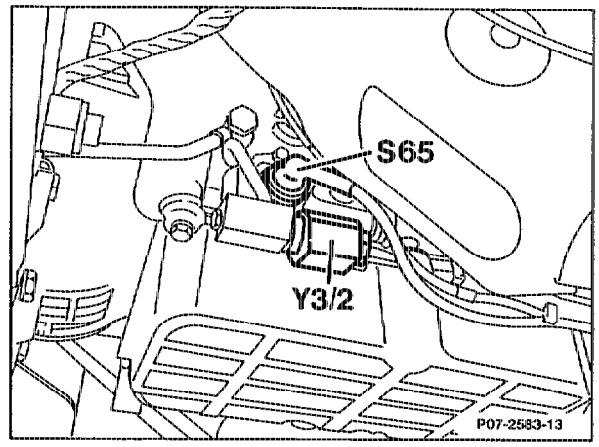
J. Transmission overload protection

General

In order to protect the shift elements or the automatic transmission from excessive thermal stresses during power shifts in the top engine speed range, a transmission overload protection is integrated in the EZL ignition control units.
As a result of the transmission overload protection, ignition timing is retarded to 5° CA before TDC for about 400 ms (reduced engine torque) during 1 → 2 and 2 → 3 upshifts (engine 120: 1 → 2, 2 → 3, 3 → 4).
As this retardation of ignition timing during the shifting phase also provides a smoother gearshift, this measure is also used during 3 → 2 full load downshifts (engine 120: 4 → 3 and 3 → 2).
Ignition timing is retarded provided the following conditions are met simultaneously:

- Engine speed >4000/min (reference value)
- Vacuum in intake manifold <300 mbar (reference value)
- Shift signal from transmission overload protection switch, brake band B1 (S65) (engine 120: brake band B1 (S65) or B2 (S65/1)).

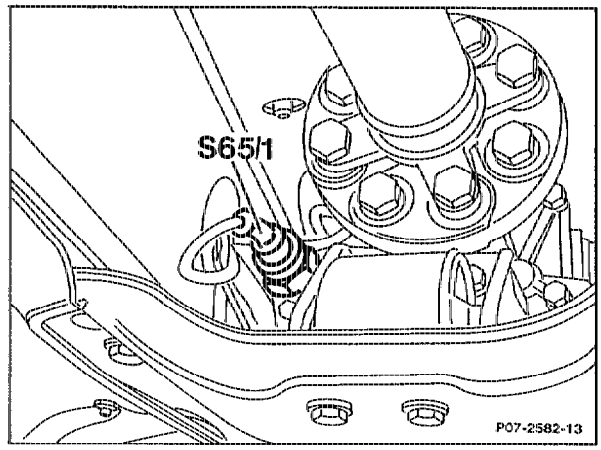
The transmission overload protection switch, brake band B1 (S65) (engine 120: brake band B1 (S65) and B2 (S65/1)) is designed as a hydraulic switch and linked to the operating pressure circuit of brake band "B1" and "B2", respectively, of the automatic transmission.
The opening and closing of the transmission overload protection switch, brake band B1 (S65) (engine 120: brake band B1 (S65) and B2 (S65/1)) is detected as a shift signal by the appropriate EZL ignition control unit.
The shift function of the transmission overload protection switch, brake band B1 (S65) is dependent on the working pressure which exists at "B1".
Working pressure < 1.8 bar: S65 opened.
Working pressure > 1.8 bar: S65 closed.



S65 Transmission overload protection switch, brake band B1
Y3/2 Shift point retard solenoid valve

Engine 120

The shift function of the transmission overload protection switch, brake band B2 (S65/1) is dependent on the working pressure which exists at "B2".
Working pressure < 1.8 bar: S65/1 opened.
Working pressure > 1.8 bar: S65/2 closed.
The opening and closing of the transmission overload protection switch, brake band B1 (S65) and B2 (S65/1) is detected as a shift signal by the appropriate EZL ignition control unit.



S65/1 Transmission overload protection switch, brake band B2

Emergency running mode transmission overload protection

If the EZL ignition control unit does not receive a shift signal from the automatic transmission when driving, whether as a result of a fault at the transmission overload protection switch, brake band B1 (S65) or brake band B2 (S65/1) or at the wiring, the appropriate EZL ignition control unit switches to emergency running mode. The transmission overload protection is active only to a restricted extent in the emergency running mode.

If no shift signal is received from the automatic transmission, the EZL ignition control unit recognizes the start of a gearshift as a result of a change in engine speed of a defined magnitude.

If the transmission overload protection is operating in the emergency running mode, this may make itself noticeable as a result of a brief retardation of ignition timing at high speed.

In the event of the complaint "misfiring at high speed" the transmission overload protection switch, brake band B1 (S65) and brake band B2 (S65/1) as well as the appropriate wiring should be checked.

K. Engine torque reduction in ASR control mode

General

Ignition timing is briefly retarded if the vehicle speed is >20 km/h during the initial ASR control cycle in order to achieve an immediate reduction in engine torque when the wheels begin spinning until the throttle valve control is activated.

The signal which is required to activate the EZL ignition control unit in this case is supplied by the electronic accelerator pedal control unit.