166 2.0 TS multi-point injection system (mpi) 1056B (Automatic transmission, Automatic transmission, Automatic transmission, Automatic transmission, Automatic transmission, Automatic transmission)

Valid for versions with:Automatic transmission

VIEW OF ASSEMBLY

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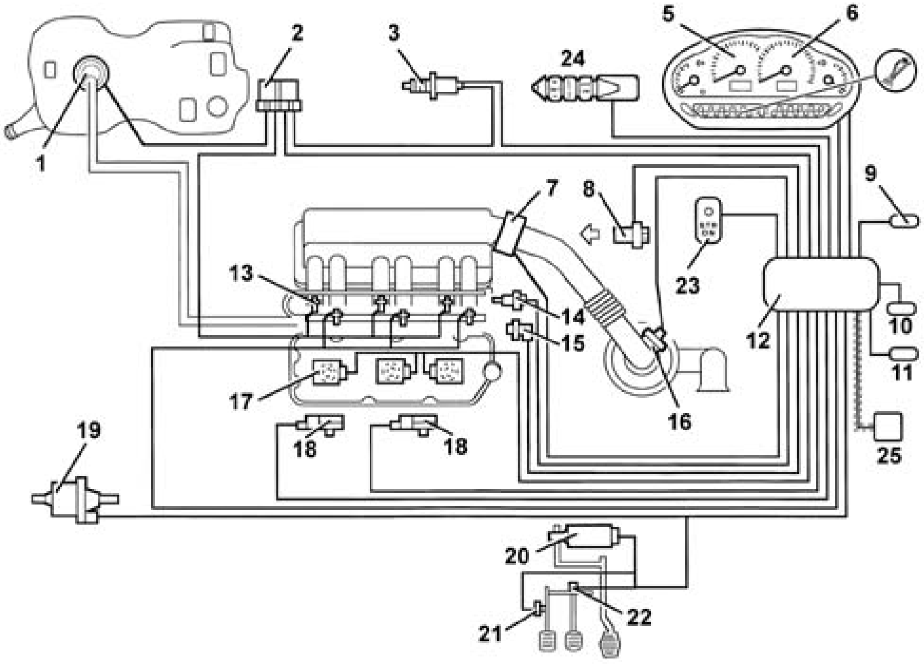

1, Electric fuel pump
2, Relays
3, Lambda sensor
4, Speedometer
5, Rev counter
6, Injection warning light
7, Butterfly casing actuator integrated with D.V.L.
8, Timing sensor
9, Climate control connector
10, Diagnostic connector
11, Alfa Romeo CODE connector
12, Injection/ignition control unit
13, Injectors
14, Coolant temperature sensor
15, Rpm sensor
16, Air flow meter with air temperature sensor
17, Ignition coils
18, Detonation sensors
19, Fuel vapour recirculation solenoid valve
20, Accelerator pedal potentiometer
21, Clutch pedal switch
22, Brake pedal switch
23, Sport throttle response
24, Cruise control
25, CAN line

GENERAL CHARACTERISTICS

Operation of the fuel injection-ignition

The Bosch Motronic ME2.1 system with a motorized butterfly belongs to the category of integrated systems with:

- ignition
- sequential and timed electronic injection.

The control unit controls the air flow rate at the idle rotation speed set by the electronic butterfly.
The control unit controls the moment of ignition with the advantage of keeping the engine running smoothly as the ambient parameters and loads applied vary.
The control unit controls and manages fuel injection so that the stoichiometric ratio (air/fuel) is always at the optimum value.

The main operating principles of the sytem are basically as follows:

- self-learning;
- system self-adaptation;
- autodiagnosis;
- recognition of the Alfa Romeo CODE (Immobilizer);
- control of cold starting;
- control of combustion - Lambda sensor;
- control of detonation;
- control of mixture enrichment during acceleration;
- fuel cut-off with accelerator pedal released;
- fuel vapour recovery;
- control of the maximum rpm;
- control of the fuel pump;
- connection to the climate control system;
- recognition of cylinder position;
- control of optimum injection time for each cylinder;
- adjustment of ignition advance values;
- management of idle speed (also according to the battery voltage);
- management of the butterfly opening law (Sport throttle response);
- control of the electric fans;
- control of the Cruise Control system (where fitted)
- connection with the ABS control unit;
- connection with the automatic transmission control unit (where fitted);
- conection with the instrument panel.

Fuel injection system

The essential conditions that must always be met in the preparation of the air-fuel mixture for the correct operation of controlled-ignition engines are mainly:

- the "metering" (air/fuel ratio) should constantly be kept as close as possible to the stoichiometric ratio, so as to ensure the maximum conversion capacity for the catalytic converter (max. efficiency).
- the "homogeneity" of the mixture, consisting of petrol, diffused as finely and evenly as possible in the air.

The information processed by the control unit for controlling optimum metering is received in the form of electrical signals emitted by the:

- air flow meter and air temperature sensor, for the exact quantity of air drawn in
- rpm sensor, which generates an alternating single-phase signal whose frequency indicates the engine rpm
- butterfly potentiometer, to recognize the acceleration conditions requested
- coolant temperature sensor located on the thermostat
- Lambda sensor for determining the oxygen content in the exhaust gases.

Ignition system

The ignition is of the inductive discharge type, distributorless, with power modules located in the fuel injection control unit.

The system has a single coil for each plug (MONOCOIL); the advantages of this solution are:

- less electrical overload;
- guaranteed constant discharge on each plug.

Stored in the control unit, there is a map containing the entire set of optimum ignition advance values (for the cylinder at the power stroke) that the engine can adopt in relation to the rpm and required engine load.

The control unit corrects the advance values mainly in accordance with the:

- engine coolant temperature
- intake air temperature
- detonation.

The information the control unit processes in order to drive the single coils is received in the form of electrical signals emitted by the:

- air flow meter and air temperature sensor, for the exact quantity of air drawn in
- rpm sensor, which generates an alternating single-phase signal whose frequency indicates the engine rpm
- detonation sensors (on the upper part of the cylinder block/crankcase between the two heads) to recognize the cylinder where detonation is occurring and correct the ignition advance
- butterfly potentiometer, to recognize the minimum, partial and full load conditions
- timing sensor.

OPERATION

Diagram of input/output information to/from the control unit

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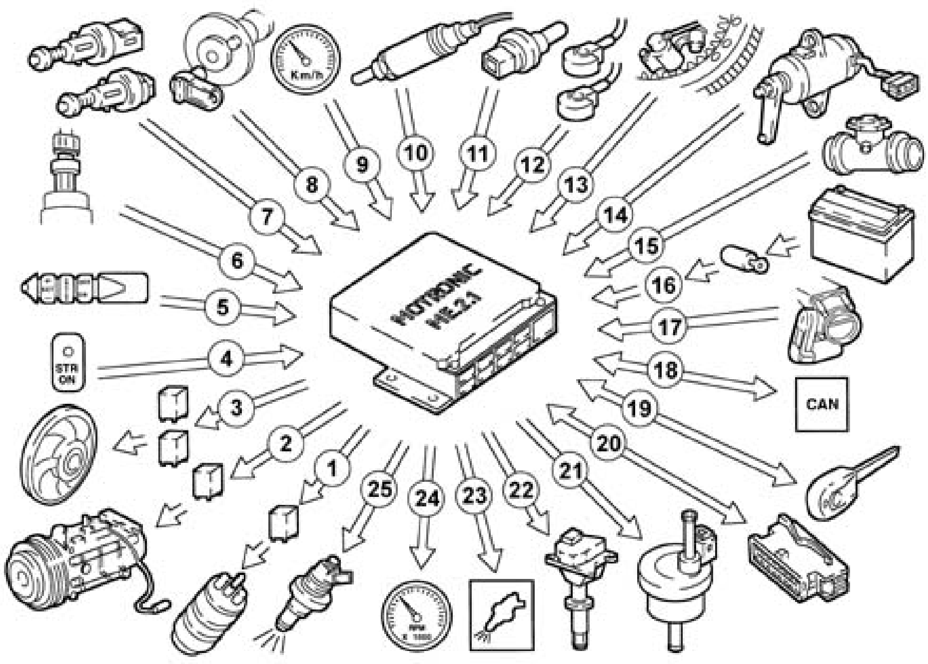


1, Electric fuel pump
2, Air conditioner compressor
3, Electric fan
4, Sport throttle response
5, Cruise control
6, Quadrinary
7, Brake/clutch pedal switch
8, Timing sensor
9, Speedometer
10, Lambda sensor
11, Coolant temperature sensor
12, Detonation sensors
13, Rpm sensor
14, Accelerator pedal potentiometer
15, Air flow meter with air temperature sensor
16, Battery
17, Butterfly casing integrated with D.V.L.
18, CAN line (for communication with ABS/ASR and automatic transmission control units)
19, Alfa Romeo CODE
20, Diagnostic socket
21, Fuel vapour recirculation solenoid
22, Ignition coils
23, Injection warning light
23, Cruise control
24, Rev counter
25, Injectors

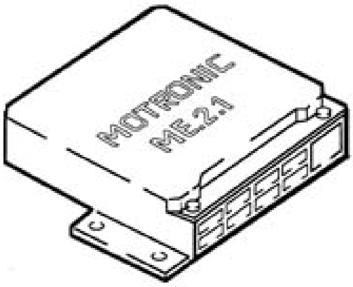
SYSTEM OPERATING LOGICS

Self-learning

The control unit implements the self-learning logic in the following conditions:

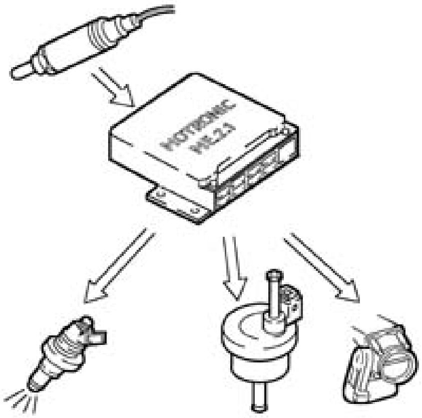
- removing-refitting or replacement of the injection control unit
- removing-refitting or replacement of the butterfly casing integrated with D.V.L.

For the self-learning procedure, see "PROCEDURES FOR REPAIRS - op. **1056B81 run electronic ignition/injection control unit (single) self-learning procedure** .
The values memorized by the control unit are preserved if the battery is disconnected.



System self-adaptation

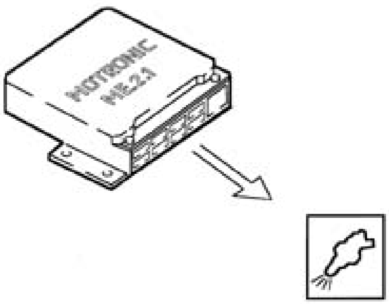
The control unit has a self-adaptation function which recognizes changes in the engine which occur as a result of bedding-in and ageing processes of both components and the engine itself.
There are two adaptation functions according to two intervention plans: minimum and usage.



Autodiagnosis

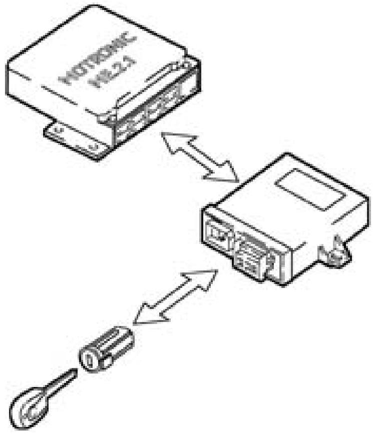
The control unit's self-test checks the signals coming from the sensors, comparing them with the permitted limits:

- indication of starting faults
- warning light on for 4 secs indicates test stage
- warning light off after 4 secs indicates no faults in components that could affect the values established in emission control regulations
- warning light on after 4 secs indicates fault
- fault indication during operation
- warning light on indicates fault
- warning light off indicates no faults in components that could affect the values established in emission control regulations
- recovery
- the control unit defines as and when required the type of recovery depending on the faulty components
- the recovery parameters are managed by non-faulty components.



Recognition of the alfa romeo code

When the control unit receives the ignition "ON" signal, it dialogues with the Alfa Romeo CODE control unit to obtain starting enablement.



Check on cold starting

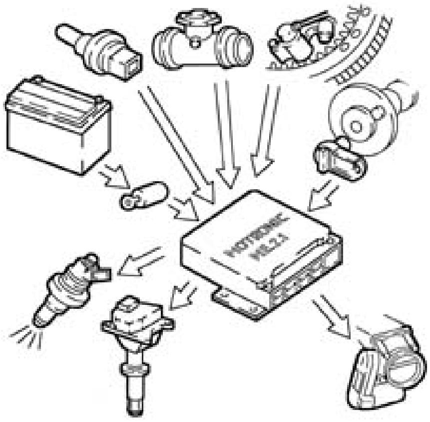
The following occurs during cold starting:

- natural weakening of the mixture because of poor turbulence of the fuel particles at low temperatures
- condensation of the fuel on the inner walls of the inlet manifold
- higher viscosity of the lubricating oil.

The electronic control unit recognizes this condition and corrects the fuel injection times in accordance with:

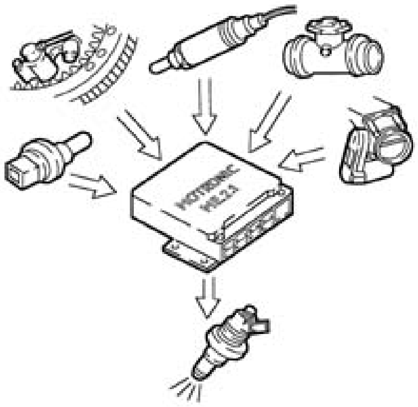
- coolant temperature
- intake air temperature
- battery voltage
- engine rpm

The ignition advance depends solely on the engine rpm and the coolant temperature.
During starting, the control unit controls a first simultaneous injection for all the injectors (full-group injection) and, after recognizing the timing of the cylinders, it starts normal sequential phased operation.
Whilst the engine is warming up, the control unit operates the butterfly casing integrated with D.V.L. to regulate the quantity of air required to ensure that the engine does not cut out.
The rotation speed decreases as the engine temperature increases until the normal value is reached with the engine at operating temperature.



Check on combustion - lambda sensor

According to the engine speed and load, the control unit processes the Lambda sensor signal using a special integrator and corrects the injector opening times.



Control of detonation

The control unit can delay the ignition selectively at the cylinder required, according to the combination of figures received from the detonation and timing sensors and:

- reduces the ignition advance in steps of 3° up to a maximum of 9°
- updates the threshold value to take into account:
- background noise;
- ageing of the engine.

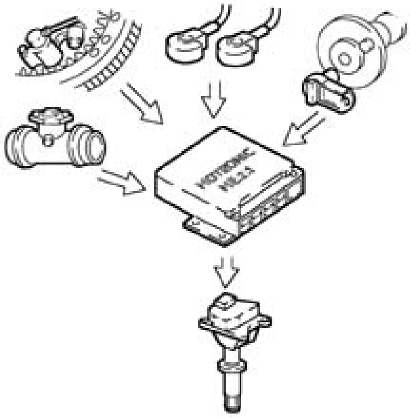
During acceleration, the control unit uses a higher threshold for the increased engine noise.
When the detonation disappears, the control unit increases the ignition advance in steps of 0.75° until it is fully restored.

With the auto-adjustment function, the control unit:

- memorizes the various advance reductions, continuously repeated;
- adapts the map to the different engine conditions.

Recovery:

- in the case of fault with the timing sensor or the detonation sensor or the injection control unit, the ignition is delayed according to the engine temperature and speed. The maximum ignition delay is always below 9° engine.

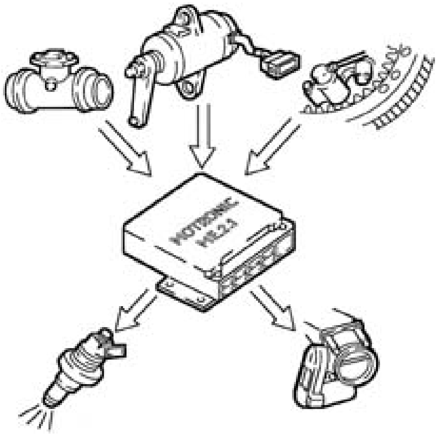


Control of the mixture enrichment during acceleration

If there is a request for considerable acceleration, the control unit modifies the injection time and the butterfly position.

Recovery:

- the control unit replaces the signal coming from the faulty air flow meter with the signal from the potentiometer integrated in the butterfly casing integrated with D.V.L.



Fuel cut-off with the accelerator pedal released

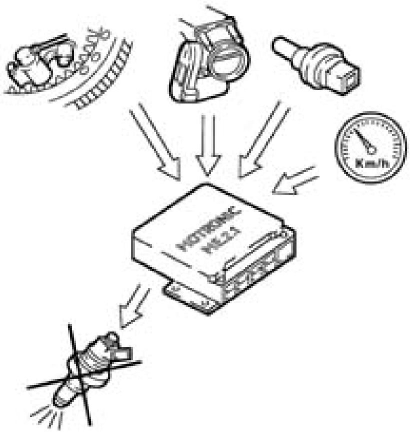
The control unit, in the following conditions:

- recognition of idle condition
- engine speed above a certain threshold

de-activates the fuel injection according to the:

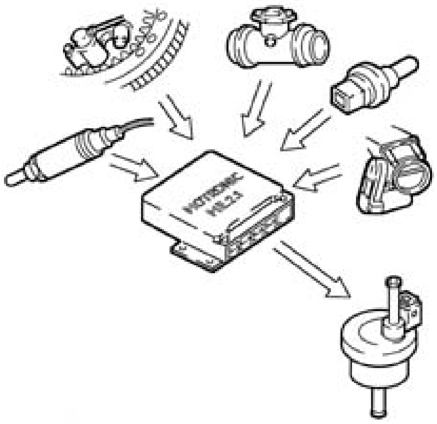
- number of revs
- engine temperature
- vehicle speed.

Before the idle conditions are reached, the dynamics of the engine speed decrease are checked.
If they exceed a certain value, the fuel supply is partly reactivated on the basis of a logic which makes provision for the "gentle accompaniment" of the engine whilst idling.
Having reached the idle condition, the normal functions are restored.
The fuel cut off is only activated 20 seconds after the engine has been started up.



Fuel vapour recovery

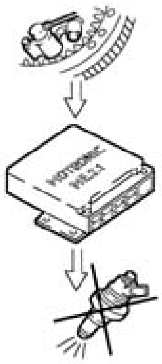
The (polluting) fuel vapours, collected in an activated-charcoal filter (canister), are sent to the inlet ducts to be burnt.
This takes place via a solenoid valve operated by the control unit which keeps it closed for 60 seconds after starting after which it keeps it open for 90 seconds.
During this period (90 seconds), the Lambda sensor measures the carburation which is compared by the control unit with the basic map.
If there are no variations, the control unit closes the solenoid valve, otherwise it keeps it open for a further 90 seconds allowing the washing of the canister.
Nominally, the filter washing flow rate is limited to a small percentage of the air flow rate meter reading so that the adjustment plan is as balanced as possible and the driveability of the vehicle is disturbed as little as possible.



Control of the maximum rpm

Depending on the rpm reached by the engine, the control unit:

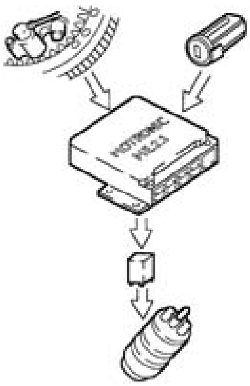
- over 6800 rpm cuts off the supply to the injectors (it is allowed to reach a maximum of 7000 rpm for a maximum of 5 secs).
- below 6600 rpm it restores the operation of the injectors.



Control of fuel pump

The control unit:

- supplies the electric fuel pump
- ignition in ON position (for 5 secs)
- ignition in AVV position and engine speed > 25 rpm
- interrupts the supply to the electric pum
- with the ignition in the OFF position
- with the engine rpm < 25 rpm.

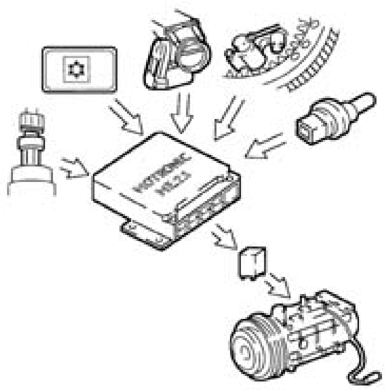


Connection to the climate control system

When the climate control is switched on, the compressor absorbs power from the engine.
In idle conditions, the control unit adapts the air flow rate to the new power requirements, with the advantage of maintaining optimum driveability.

The control unit excludes the compressor:

- beyond 6500 rpm;
- beyond a certain engine coolant temperature level (117° C);
- during starting



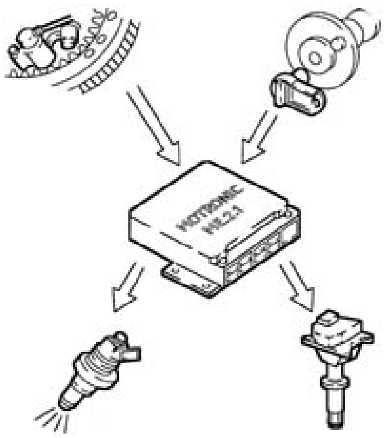
Recognition of cylinder position

During each engine revolution, the control unit recognizes which cylinder is at the power stroke:

- it controls the injection and ignition sequence for the appropriate cylinder.

If the timing sensor is faulty, the control unit does not recognize whether cylinder no. 1 or cylinder no. 5 is in the explosion stroke and implements the following strategies:

- with the engine started up, the engine runs smoothly thanks to the cylinder sequence memory
- if the engine cuts out and is started up again, the ignition in pairs of coils is activated, the control of the detonation is deactivated and a fixed delay is applied for all cylinders.



Control of the optimum injection time for each cylinder

According to special maps, the control unit calculates the optimum injection time for each cylinder:

- it modifies the injector opening starting "point"
- it keeps the closing "point" in the map, selected on the basis of the engine speed, fixed
- the fuel injection is sequential and timed for each cylinder (S.E.F.I.).

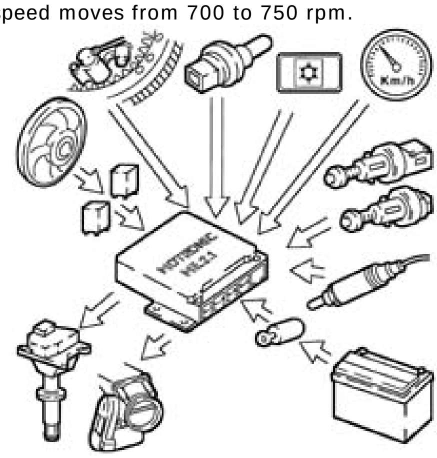
Adjustment of ignition advance values

The control unit processes the signals coming from the sensors and determines:

- the ignition advance for each cylinder
- the ignition delay at the cylinder required (according to the detonation).

Control of the idle speed

The control unit recognizes the idle condition from the accelerator pedal being in the "released" position.
According to the consumers switched on and the brake/clutch pedal signals, the control unit controls the position of the motorized butterfly.
With the second fan speed engaged, the idle speed moves from 700 to 750 rpm.



Management of the butterfly opening - sport throttle response

(where fitted)

The control unit processes the signals coming from the:

- sport throttle response button
- accelerator pedal potentiometer

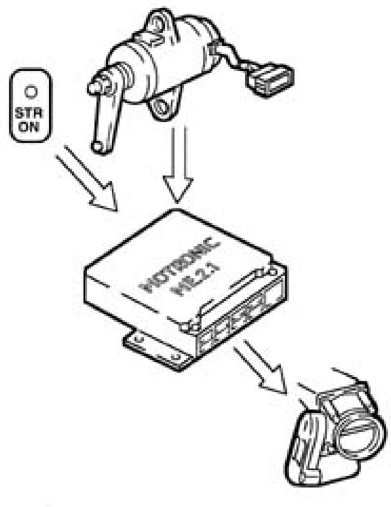
for the management of the butterfly in the following modes:

- "SPORT" for sports driving
- "COMFORT" for good driveability and a comfortable ride.

The switch from the "COMFORT" to the "SPORT" setting is activated:

- by pressing the sport throttle response switch and completely releasing the accelerator pedal
- automatically by pressing the accelerator pedal rapidly.

The activation of the function is signalled by a special LED in the button.
The switch from the "SPORT" to the "COMFORT" setting only takes place by pressing the sport throttle response button and releasing the accelerator pedal.

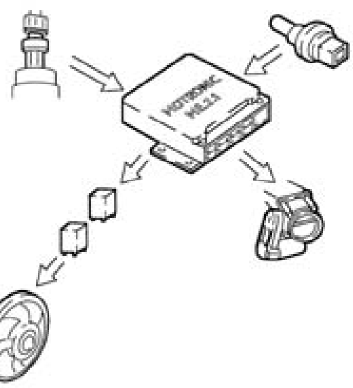


Control of the electric fans

The control unit controls the switching on of the electric fan in accordance with the coolant temperature:

- temperature for switching on 1^{st} speed 95° C
- temperature for switching on 2^{nd} speed 102° C

If the air conditioning system is switched on, the control unit engages the 1^{st} fan speed.
In the absence of the coolant temperature signal, the control unit activates the recovery function and switches on the fan 2^{nd} speed until the error disappears.
Before the fans are operated, the idle speed is adjusted through an increase in the variable air flow rate for the fan to be activated.



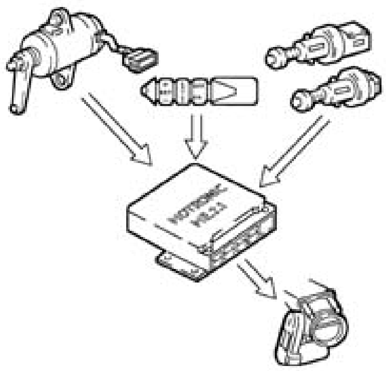
Control of the cruise control system (where fitted)

According to the position of the Cruise Control lever, the control unit directly operates the motorized butterfly to control and maintain the vehicle speed memorized.
A warning light in the dashboard, activated by the control unit, indicates whether the system is operating or not.

The cruise control is momentarily disabled:

- by operating the brake,
- by operating the clutch;

the "recall" button is used to return to the speed memorized.
The cruise control is not disabled if there is an acceleration request (e.g. overtaking) and the vehicle automatically returns to the speed set as soon as the accelerator is released.
The ASR (anti-spin) function has priority over the cruise control for safety reasons.

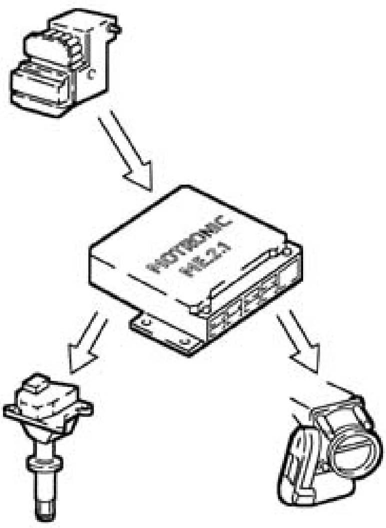


Connection with the abs/asr control unit (where fitted)

The dialogue between the engine control unit and the ABS/ASR control unit takes place via the CAN line available on both control units.

If the wheels are slipping (signalled by the ABS/ASR control unit), the control unit reduces the drive torque through:

- a reduction in the ignition advances.
- a reduction in the butterfly opening angle.



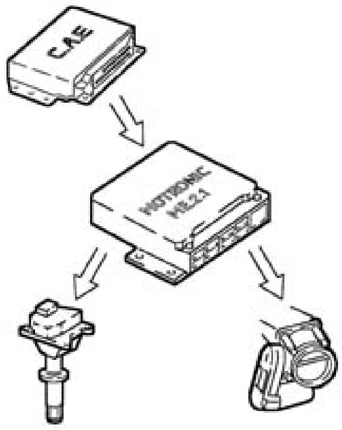
Connection with the automatic transmission control unit (where fitted)

The dialogue between the engine control unit and the CAE automatic transnmission control unit takes place via the CAN line available on both control units.

If the wheels are slipping (signalled by the CAE control unit), the injection control unit reduces the drive torque through:

- a reduction in the ignition advances.
- a reduction in the butterfly opening angle.

Recovery: if the CAN line is faulty, the injection control unit identifies the position (D - P - N) of the gear selector through the signal coming from a switch under the actual selector. If the lever is in position D, the control unit reduces the torque.
The CAE control unit implements a special recovery logic.



ME2.1 INJECTION/IGNITION CONTROL UNIT

The control unit is mounted in the interior compartment on the passenger side panel.
The control unit memory is the "flash EPROM" type, i.e. it is reprogrammable from the outside without intervening on the hardware.
The replacement of the injection control unit or the integrted butterfly casing means that the self-learning procedure has to be carried out (see op. **1056B81 run electronic ignition/injection control unit (single) self-learning procedure**).

Pin-out

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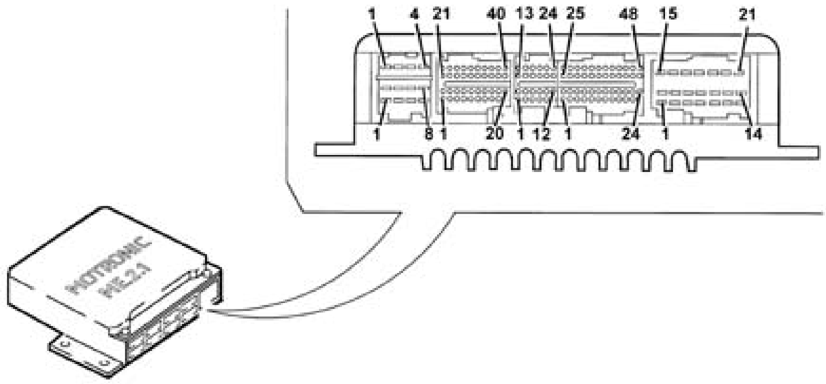


A-1, N.C.
A-2, Supply
A-3, Igntion earth
A-4, N.C.
A-5, Lambda sensor heater
A-6, Relay for 1 st fan speed
A-7, Ignition earth
A-8, Electronic earth (for sensors)
B-1, N.C.
B-2, N.C.
B-3, Programming
B-4, Battery
from C-1 to C-20, N.C.
C-21, Fuel vapour recovery solenoid valve
C-22, Supply for potentiometer - 1 accelerator pedal
C-23, Earth for potentiometer - 1 accelerator pedal
C-24, Signal for potentiometer - 1 accelerator pedal
C-25, Signal for potentiometer - 2 accelerator pedal
C-26, Earth for potentiometer - 2 accelerator pedal
C-27, Supply for potentiometer - 2 accelerator pedal
C-28, Sport throttle response on warning light
C-29, Fuel pump relay
C-30, N.C.
C-31, Lambda sensor earth
C-32, Lambda sensor signal
from C-33 to C-37, N.C.
C-38, Rpm signal
C-39, Diagnostic connection (line K)
C-40, N.C.
D-1, N.C.
D-2, N.C.

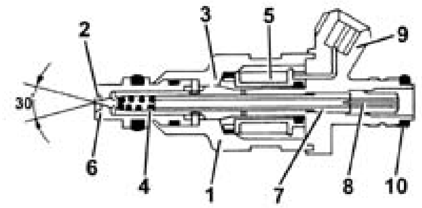
D-3, Relay for cooling fan 2 nd speed
D-4, N.C.
D-5, CAE gear selector switch
from D-6 to D-10, N.C.
D-11, CAN line "high"
D-12, CAN line "low"
D-13, Speedometer signal
D-14, Brake lights switch
from D-15 to D-16, N.C.
D-17, CAE recognition
D-18, N.C.
D-19, Clutch pedal switch
D-20, Cruise control set +
D-21, Cruise control set -
D-22, Cruise control - recall
D-23, Brake switch
D-24, Cruise control deactivation
E-1, Operation of injector for cyl. 3
E-2, Operation of injector for cyl. 6
E-3, N.C.
E-4, Air conditioning compressore relay feed
from E-5 to E-9, N.C.
E-10, Cruise control on warning light
E-11, N.C.
E-12, N.C.
E-13, Operation of injector for cyl. 2
E-14, Operation of injector for cyl. 5
E-15, Air conditioning pressure switch 1st stage
E-16, N.C.
E-17, Air conditioning pressure switch 2nd stage
from E-18 to E-20, N.C.
E-21, Air conditioning request switch
E-22, N.C.
E-23, Sport throttle response switch
E-24, Sport throttle response switch earth
E-25, Operation of injector for cyl. 1
E-26, Operation of injector for cyl. 4
E-27, N.C.
E-28, Coolant temperature sensor earth
E-29, Coolant temperature sensor signal
E-30, N.C.
E-31, Potentiometer - 1 butterfly casing
E-32, Earth for potentiometer 1-2 butterfly casing
E-33, Supply for potentiometer 1-2 butterfly casing
E-34, Potentiometer - 2 butterfly casing
E-35, N.C.
E-36, N.C.
E-37, Rpm sensor (-)
E-38, Rpm sensor (+)
E-39 Timing sensor earths
E-40, Timing sensor signal
E-41, Earth for detonation sensor 1 (cylinders 1-4-5)
E-42, Signal for detonation sensor 1
E-43, Earth for detonation sensor 2 (cylinders 2-3-6)
E-44, Signal for detonation sensor 2
E-45, Air temperature sensor
E-46, Flow meter - reference voltage 5V
E-47, Output voltage (signal) - flow meter
E-48, Earth - flow meter
F-1, Butterfly casing motor integrated with D.V.L. (-)
F-2, Butterfly casing motor integrated with D.V.L. (+)
F-3, N.C.
F-4, N.C.
F-5, Operation of ignition coil for cyl. 6
F-6, Operation of ignition coil for cyl. 2
F-7, N.C.
F-8, Earth
from F-9 to F-12, N.C.
F-13, Operation of ignition coil for cyl. 4
F-14, N.C.
F-15, N.C.
F-16, N.C.
F-17, Operation of ignition coil for cyl. 3
F-18, N.C.
F-19, Operation of ignition coil for cyl. 5
F-20, Operation of ignition coil for cyl. 1
F-21, Operation of injection warning light

INJECTORS

The single-jet type injectors (with a larger diameter jet for the 3.0 version) are fitted on the distribution manifold and are pressed by the actual manifold into their seats in the inlet ducts.
A retainer secures the fuel injector to the distribution manifold, and two O-rings ensure the seal.
The fuel injectors are responsible for delivering the necessary quantity of fuel to the engine.
They are "all or nothing" devices, as they can remain in only two stable states, i.e. open or closed. They allow fuel to pass when they are open, while they block delivery when they are closed.

Operation

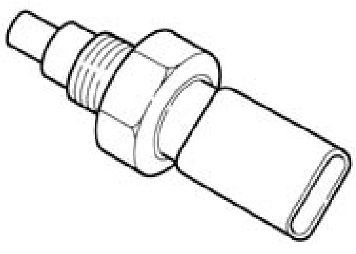
They basically consist of a nozzle controlled by a solenoid and a return spring (4).
In the rest position, the pintle (2), which is joined to the core (3), is pushed by the spring onto the injector nose (6), thus closing the hole, ensuring a seal and preventing the unrequired emergence of fuel.
As soon as the winding (5) is energized, the core is attracted, and it compresses the spring thus opening the hole of the nozzle and allowing fuel to emerge.
Considering the physical characteristics of the fuel (viscosity, density) and the pressure drop (via the pressure regulator) to be constant, the quantity of fuel injected depends only on the fuel injector opening time.
The winding energization time is normally indicated as "fuel injection time".



1, Injector body
2, Pintle
3, Magnetic core
4, Coil spring
5, Winding
6, Injector nose
7, Adjustable spring pusher
8, Filter
9, Electrical connection
10, Seal

ENIGINE COOLANT TEMPERATURE SENSOR

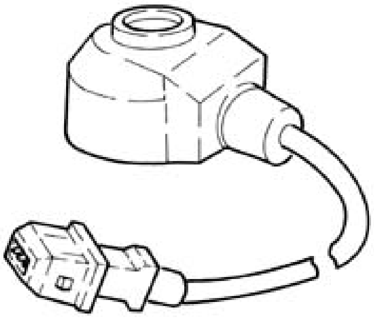
It is fitted on the thermostatic cup and measures the temperature of the coolant by means of an NTC thermistor which has a negative resistance coefficient.
One NTC thermistor sends the signal to the injection control unit whilst the other sends the signal to the temperature gauge and warning light in the instrument panel.



The sensor is constructed using semiconductor technology; therefore if the temperature of the sensor increases as the temperature of the coolant increases, the resistive value decreases.
As the variation in resistance is not linear, for the same temperature increment, it is higher for low temperatures than for high temperatures.

DETONATION SENSORS

The piezoelectric type detonation sensors are fitted on the cylinder block/crankcase, between the two heads, and measure the intensity of the vibrations caused by the detonation in the combustion chambers.
The piezoelectric crystal forming the sensor detects the vibrations generated at a frequency of between 12 and 16 kHz, and transforms them into electrical signals sent to the fuel injection control unit.
The tightening torque for the bolt fixing the detonation sensors is 1.95 - 2.05 daNm.

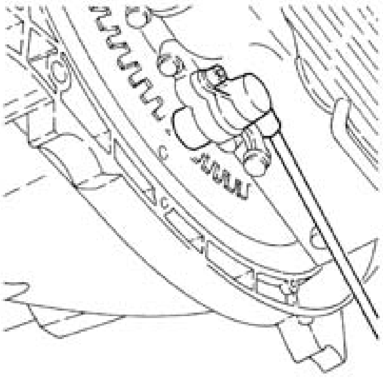


RPM AND TDC SENSOR

This is fitted on the cylinder block/crankcase, "facing" the phonic wheel on the engine flywheel.
It is of the inductive type, i.e. it functions by means of the variation in the magnetic field generated by the passage of the teeth of the phonic wheel (60-2 teeth).

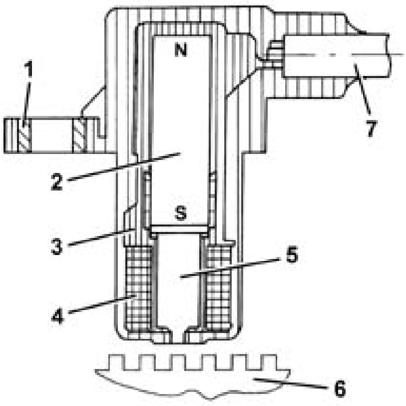
The fuel injection control unit uses the rpm sensor to:

- determine the speed of rotation
- determine the angle of the crankshaft.



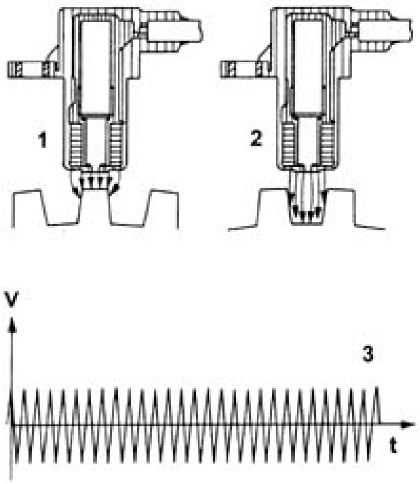
Operation

The passage from full to empty, due to the presence or absence of the tooth, causes a variation in the magnetic flow which is sufficient to generate an induced alternating voltage, resulting from the count of teeth located on a ring (or phonic wheel).
The frequency and range of the voltage sent to the electronic control unit provides it with the angular speed.



1, Brass bush
2, Permanent magnet
3, Plastic sensor casing
4, Coil winding
5, Polar core
6, Toothed or phonic wheel
7, Coaxial two-wire cable or electrical connection

The specified gap for obtaining correct signals, between the end of the sensor and the phonic wheel, must be between 0.8 and 1.5 mm. This gap is not adjustable, so if a value outside the tolerance range is measured, check the condition of the sensor and the phonic wheel.



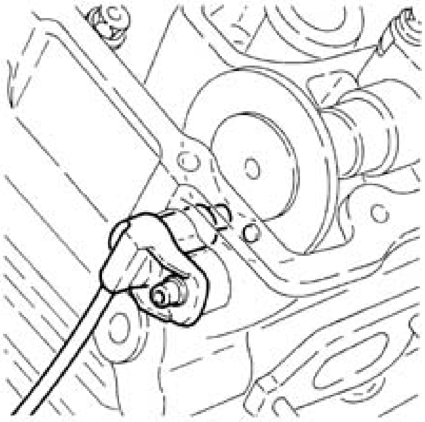
1, Maximum magnetic flow
2, Minimum magnetic flow
3, Trend of induced alternating voltage

Specifications:

- Winding resistance at 20° C: 860 Ohm ± 10%

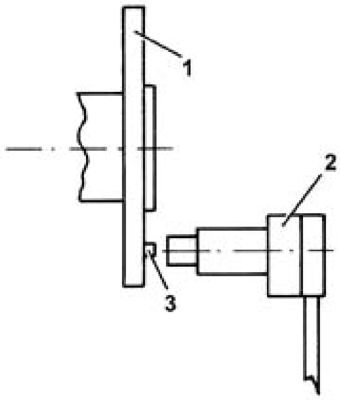
TIMING SENSOR

Hall effect, it is fitted on the right cylinder head "facing" the disc on the rear of the exhaust camshaft for the right cylinder head.
The disc contains a peg which allows the sensor to signal the engine timing position.
The fuel injection control unit uses the timing sensor's signal to find out the TDC at the end of compression.



Operation

A semiconducting layer, through which current passes, immersed in a perpendicular magnetic field (force lines perpendicular to the current direction), generates at its ends a difference in potential known as Hall voltage.
Whilst the disc (1) rotates, when the tooth (3) passes over the sensor (2), it blocks the magnetic field with a consequent "low" output signal.
Conversely, after the tooth (3) passes the sensor (2), the signal becomes "high".
Consequently the high signal alternates with the low signal every two engine revolutions, to be precise when cylinder no. 1 is 58° before TDC.



1, Camshaft disc
2, Timing sensor
3, Tooth

ACCELERATOR PEDAL POTENTIOMETER

The accelerator pedal is fitted with two integrated potentiometers:

- one main one
- one safety one.

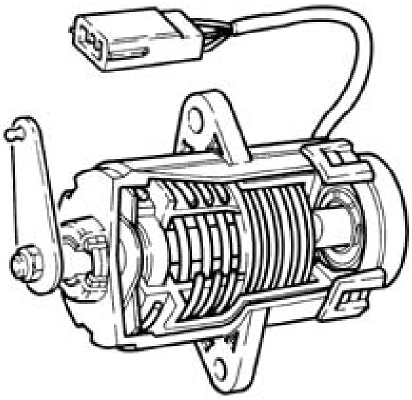
The injection control unit implements the following "recovery" strategies

- if there is a fault with one of the two potentiometers, a butterfly opening of up to 40° is allowed for a long period
- if both of the potentiometers fail completely, the butterfly opening is excluded.

The accelerator pedal is adjusted by excluding the end of travel (this position should not be exceeded).

Operation

The sensor consists of a casing (1), fixed to the pedals by a flange, which contains a shaft (2), in an axial position, connected to the twin track poteniometer (3).
There is a coil spring on the shaft which guarantees the correct resistance to the pressure whilst a second spring ensures the return on release.
Operating range from 0° to 70°; mechanical cut out at 88°.



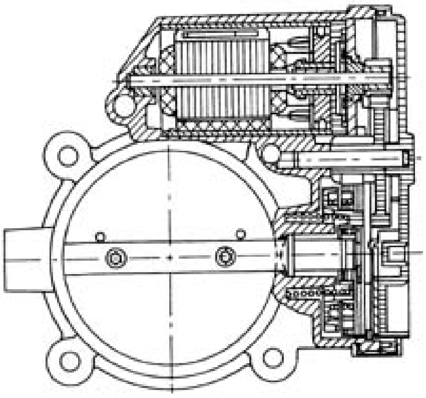
BUTTERFLY CASING INTEGRATED WITH D.V.L.

It is fitted on the inlet chamber and regulates the quantity of air drawn in by the engine.
According to the signal coming from the accelerator pedal potentioemter, the injection control unit controls the opening of the butterfly by mens of a direct current motor integrated in the butterfly casing integrated with D.V.L.
The butterfly opening takes place between 0° and 80° therefore including the idle adjustment.
The butterfly casing integrated with D.V.L. is equipped with two potentiometers integrated so that one controls the other and viceversa.

If both the potentiometers fail or there is no supply, depending on the position of the accelerator pedal, the control unit reduces the drive torque:

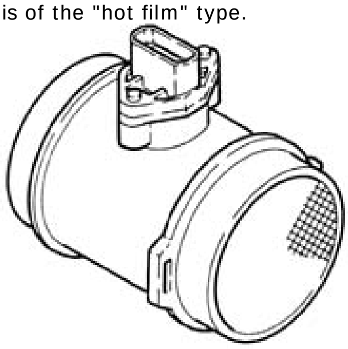
- fully depressed, it cuts off the supply to one or more pistons, until a maximum speed of 2500 rpm is reached.
- in intermediate positions, it cuts off the supply to one or more pistons, until a speed below 2500 rpm is reached.

The replacement of the butterfly casing integrated with D.V.L. or the injection control unit, means that the "self-learning" procedure must be carried out (see "PROCEDURES FOR REPAIRS - op. **1056B81 run electronic ignition/injection control unit (single) self-learning procedure**).

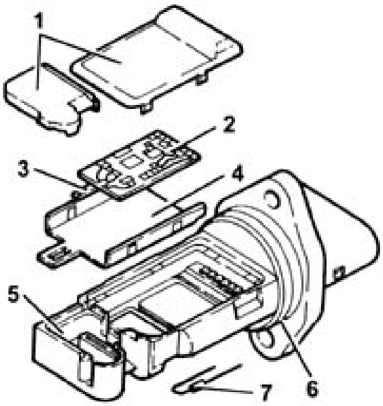


AIR FLOW METER WITH AIR TEMPERATURE SENSOR

The flow meter is located on the air inlet duct and is of the "hot film" type.



The intake air temperature sensor is built into the flow meter.



1, Covers
2, Electronic card
3, Sensor
4, Support plate
5, Support
6, O-ring
7, Temperature sensor

The air flow meter cannot be dismantled.

Operation

The principle of operation is based on a heated diaphragm located in a measuring duct through which the intake air entering the engine flows.
The hot film diaphragm is kept at a constant temperature (about 120° C above the incoming air temperature) by the heating resistor.
The air mass passing through the measuring duct tends to draw heat from the diaphragm, so to keep the latter at a constant temperature, some current must flow through the resistor.
This current is measured by a suitable Wheatstone bridge.
The current is therefore proportional to the mass of flowing air.
The flow meter directly measures the air mass (not volume), thus eliminating problems of temperature, altitude, pressure, etc.

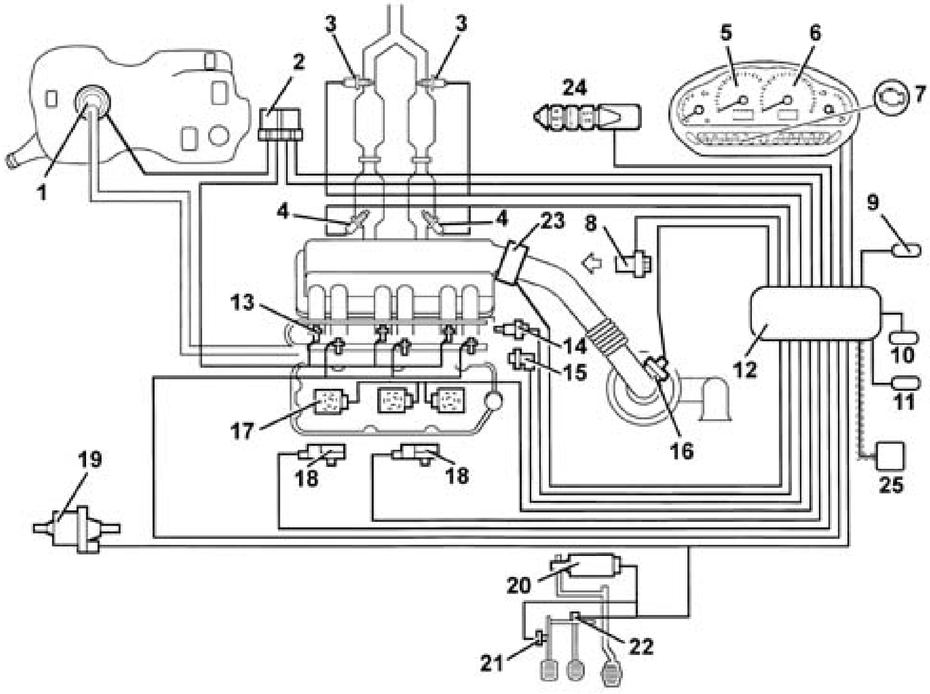
Specifications:

- nominal flow rate (with voltage 4.56 V): 640 kg/h
- nominal resistance at 25° C: 2.0 kOhm ± 5%

Valid for versions with:Automatic transmission, Euro 3

CONSTRUCTION FEATURES

View of assembly



1, Electric fuel pump
2, Relays
3, Lambda sensors downstream of catalyzer
4, Lambda sensors upstream of pre-catalyzer
5, Rev counter
6, Speedometer
7, Injection warning light
8, Timing sensor
9, Climate control connector
10, Diagnostic connector
11, Alfa Romeo CODE connector
12, Injection/ignition control unit
13, Injectors
14, Coolant temperature sensor
15, Rpm sensor
16, Air flow meter with air temperature sensor
17, Ignition coils
18, Detonation sensors
19, Fuel vapour recirculation solenoid valve
20, Accelerator pedal potentiometer
21, Clutch pedal switch
22, Brake pedal switch
23, Throttle body actuator integrated with D.V.L.
24, Cruise control
25, CAN line

GENERAL CHARACTERISTICS

Operation of the injection/ignition system

The Bosch Motronic ME3.1 system with a motorized throttle belongs to the category of integrated systems with:

- ignition
- sequential and phased electronic injection.

The control unit controls the air flow rate at the rotation speed set through the electronic throttle.

The control unit controls the moment of ignition with the advantage of keeping the engine running smoothly as the ambient parameters and loads applied vary.
The control unit controls and manages the injection so that the air/fuel ratio is always sufficiently close to the stoichiometric value to maximize the conversion efficiency of the catalyzers. In full power and high usage conditions, the mixture is enriched to guarantee maximum performance.

The main operating principles of the sytem are basically as follows:

- self-learning;
- system self-adaptation;
- autodiagnosis;
- recognition of the Alfa Romeo CODE (Immobilizer);
- control of cold starting;
- control of combustion - Lambda sensor;
- control of knock;
- control of mixture enrichment during acceleration;
- fuel cut-off with the accelerator pedal released;
- fuel vapour recovery;
- control of the maximum rpm;
- control of the fuel pump;
- connection to the climate control system
- recognition of cylinder position;
- control of the optimum injection time for each cylinder;
- adjustment of ignition advance values;
- management of the idle speed (also according to the battery voltage);
- control of the electric fans;
- control of the Cruise Control system (where fitted);
- connection with ABS control unit;
- connection with the automatic transmission control unit (where fitted);
- connection with the instrument panel;
- fuel system diagnosis;
- catalyzer diagnosis;
- detection of misfire;
- Lambda sensors diagnosis.

Fuel injection system

The essential conditions that must always be met in the preparation of the air-fuel mixture for the correct operation of controlled-ignition engines are mainly:

- the 'metering' (air/fuel ratio) should constantly be kept as close as possible to the stoichiometric ratio, so as to ensure the maximum conversion capacity for the catalytic converter (max. efficiency).
- the 'homogeneity' of the mixture, consisting of petrol, diffused as finely and evenly as possible in the air.

The information processed by the control unit for controlling optimum metering is received in the form of electrical signals emitted by:

- air flow meter and air temperature sensor, for the exact quantity of air drawn in
- rpm sensor, which generates an alternating single-phase signal whose frequency indicates the engine rpm
- throttle potentiometer, to recognize the driver conditions requested
- coolant temperature sensor located on the thermostat
- Lambda sensors for determining the oxygen content of the exhaust gases.

There are two Lambda sensors in the exhaust system at the intake for the pre-catalyzers.
There are also two other Lambda sensors, downstream of the catalyzers, for determining the efficiency of the catalyzers and for correcting the injection times for the two main bearings in order to always guarantee maximum conversion efficiency of the catalyzers over a period of time.

Ignition system

The ignition is of the inductive discharge type, distributorless, with power modules located in the fuel injection control unit.

The system has a single coil for each plug (MONOCOIL); the advantages of this solution are:

- less electrical overload;
- guarantee of constant discharge at each spark plug.

Stored in the control unit, there is a map containing the entire set of optimum ignition advance values (for the cylinder at the power stroke) that the engine can adopt in relation to the rpm and required engine load.

The control unit corrects the advance values mainly in accordance with:

- engine coolant temperature
- intake air temperature
- detonation.

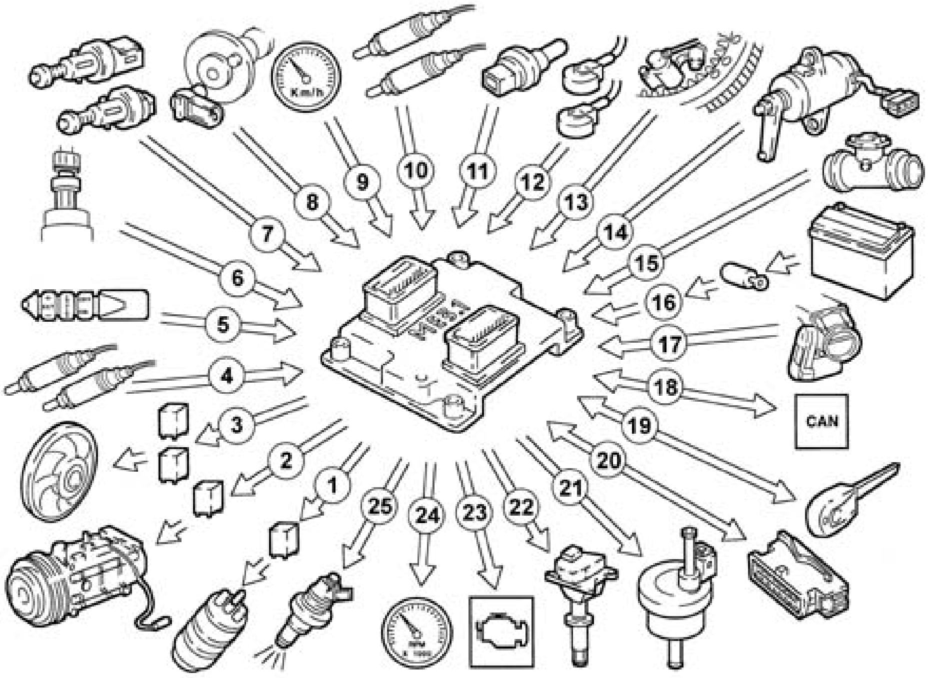
The information which the control unit processes to operate the ignition coils is received by means of electrical signals emitted by the:

- air flow meter and air temperature sensor, for the exact quantity of air drawn in
- rpm sensor, which generates an alternating single-phase signal whose frequency indicates the engine rpm
- detonation sensors (on the upper part of the cylinder block/crankcase between the two heads) to recognize the cylinder where detonation is occurring and correct the ignition advance
- throttle potentiometer, to recognize the minimum, partial and full load conditions
- timing sensor.

The control unit uses the rpm signal to recognize any misfire which could damage the catalyzers.

OPERATION

Diagram of input/output info to/from control unit



1, Electric fuel pump
2, Air conditioner compressor
3, Electric fan
4, Lambda sensors upstream of the pre-catalyzers
5, Cruise control
6, Quadrinary
7, Brake/clutch pedal switch
8, Timing sensor
9, Speedometer
10, Lambda senors downstream of the catalyzers
11, Coolant temperature sensor
12, Detonation sensors
13, Rpm sensor
14, Accelerator pedal potentiometer
15, Air flow meter with air temperature sensor
16, Battery
17, Butterfly casing integrated with D.V.L.
18, CAN line (for communication with ABS/ASR and automatic transmission control units)
19, Alfa Romeo CODE
20, Tester connection
21, Fuel vapour recirculation solenoid
22, Ignition coils
23, Injection warning light
24, Rev counter
25, Injectors

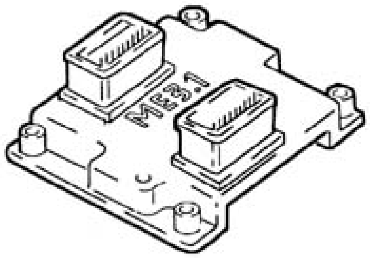
System operating modes

Self-learning

The control unit implements the self-learning mode in the following conditions:

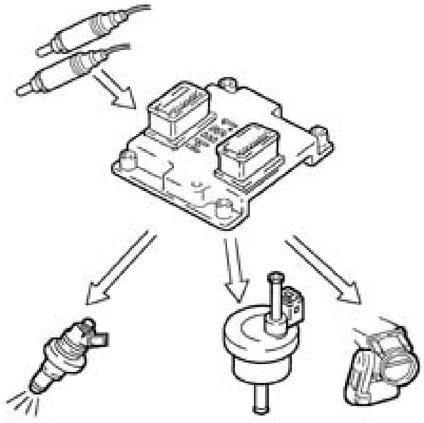
- removing-refitting or replacement of the injection control unit
- removing-refitting or replacement of the throttle body integrated with D.V.L.
- removing-refitting or replacement of the rpm sensor/flywheel for recognizing misfire.

The values memorized by the control unit are preserved if the battery is disconnected.



System self-adaption

The control unit has a self-adaption function which recognizes changes in the engine which occur as a result of bedding-in and ageing processes of both components and the engine itself.
There are two adaptation functions according to two intervention plans: minimum and usage.



Self-testing

The control unit autodiagnostic system controls the correct operation of the system and signals any faults by means of an (MIL) warning light in the instrument panel which has a standardized European colour and ideogram. This warning light signals both engine management faults and problems detected by the EOBD strategies.

The (MIL) warning light operating logic is as follows:

- with the ignition key in the ON position, the warning light comes on and remains on until the engine has been started up. The control unit's self-test checks the signals coming from the sensors, comparing them with the permitted limits:

Signalling of faults during engine starting:

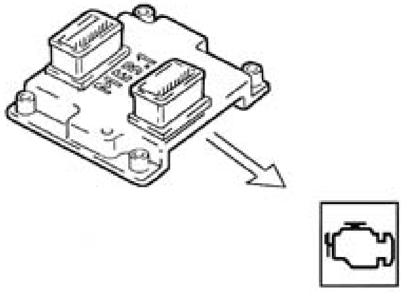
- the failure of the warning light to go out after the engine has been started up means that there is an error memorized in the control unit.

Fault indication during operation

- the warning light flashing indicates possible damage to the catalyzer due to misfire.
- the warning light on constantly indicates the presence of engine management errors or EOBD errors.

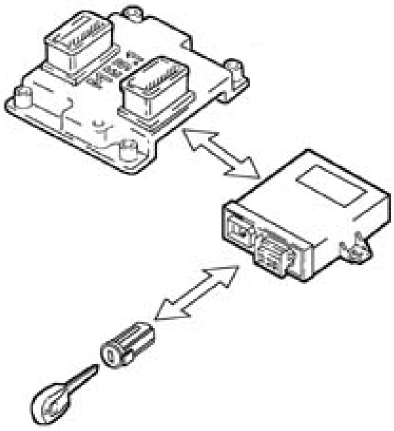
RECOVERY
From time to time, the control unit defines the type of recovery according to the components which are faulty. The recovery parameters are managed by those components which are not faulty.

For some markets the warning light is read (rather than amber) and the EOBD is not active, and the warning light only signals faults in the fuel injection system as in the preceding versions. This is achieved with a specific engine management control unit (not interchangeable with the others) with modified software so as not to have the EOBD function.



Recognition of the alfa romeo code

When the control unit receives the ignition 'ON' signal, it communicates with the Alfa Romeo CODE control unit to obtain starting enablement.



Control of cold starting;

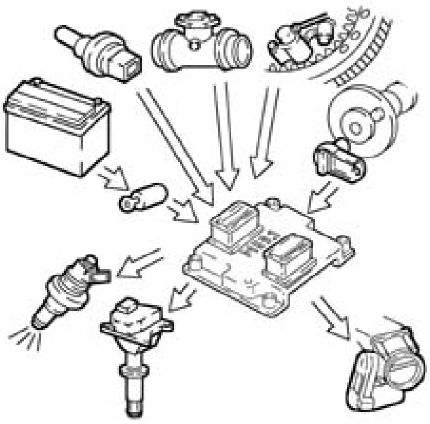
In cold starting conditions there is a natural weakening of the mixture which causes poor evaporation of the fuel at low temperatures:

- condensation of the fuel on the inner walls of the inlet manifold
- increased viscosity of the lubricant oil.

The electronic control unit recognizes this condition and corrects the fuel injection time in accordance with:

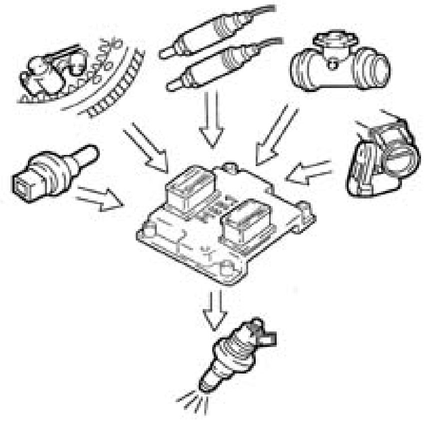
- coolant temperature
- intake air temperature
- battery voltage
- engine rpm.

The ignition advance depends solely on the engine rpm and the coolant temperature.
During starting, the control unit controls a first simultaneous injection for all the injectors (full-group injection) and, after recognizing the timing of the cylinders, it starts normal sequential phased operation.
Whilst the engine is warming up, the control unit operates the throttle body integrated with D.V.L. to regulate the quantity of air required to ensure that the engine does not cut out.
The rpm is made to decrease as the temperature of the engine increases until the optimum value with the engine warmed up is obtained.



Check on combustion - lambda probe

In EOBD systems the Lambda sensors, which are all the same type, are located upstream of the catalyzer and downstream of the catalyzer. The upstream sensors carry out the check on the mixture strength known as the 1st loop (upstream sensor closed loop). The sensors downstream of the catalyzer are used for the catalyzer diagnosis and for finely modulating the 1st loop control parameters.
With this in mind, the adjustment of the second loop is designed to recover both production differences and those in the response of the upstream sensors which may occur as a result of ageing and pollution. This control is known as the 2nd loop (downstream sensor closed loop).



Knock control

The control unit can delay the ignition selectively at the cylinder required, according to the combination of figures received from the detonation and timing sensors and:

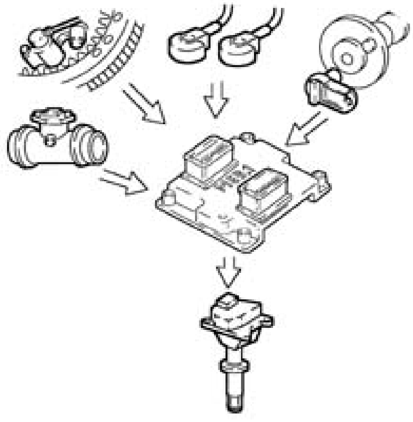
- reduces the ignition advance in steps of 3° up to a maximum of 9°
- updates the level to take into account background noise and ageing of the engine.

During acceleration, the control unit uses a higher threshold for the increased engine noise.
When the detonation disappears, the control unit increases the ignition advance in steps of 0.75° until it is completely recovered.

With the auto-adjustment function, the control unit:

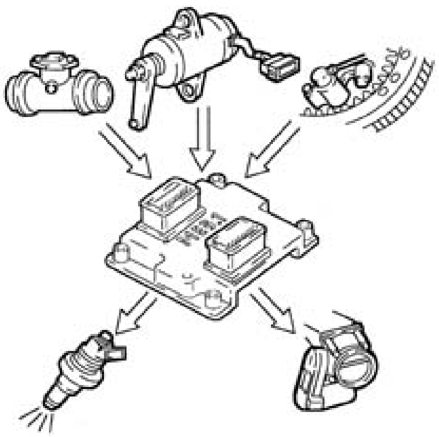
- memorizes the various advance reductions, continuously repeated;
- adapts the map to the different engine conditions.

RECOVERY
In the case of fault with the timing sensor or the detonation sensor or the injection control unit, the ignition is delayed according to the engine temperature and speed. The maximum ignition delay is always below 9° engine.



Control of mixture enrichment during acceleration;

When there is a considerable acceleration request, the control unit modifies the injection time and the position of the butterfly.
RECOVERY
The control unit replaces the signal coming from the faulty air flow meter with the signal from the potentiometer integrated in the throttle body integrated with D.V.L.



Fuel cut-off with the accelerator pedal released

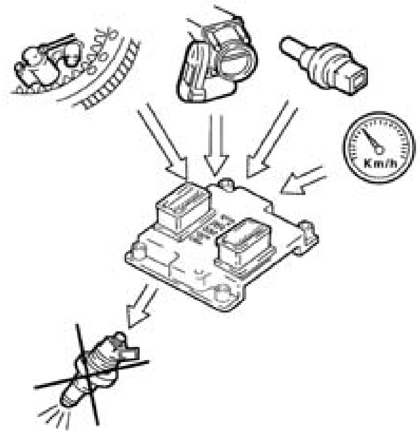
The control unit with:

- recognition of idle condition
- engine speed above a certain threshold

de-activates the fuel injection according to the:

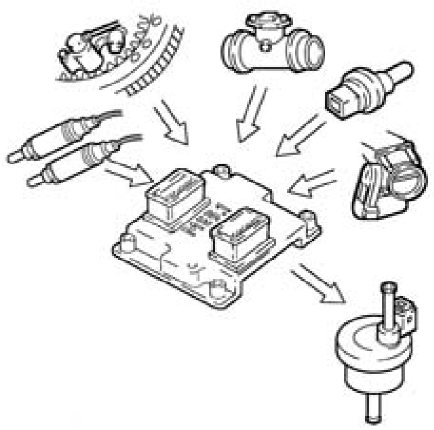
- engine rpm
- engine temperature
- vehicle speed.

Before reaching the idle condition, the dynamics of the engine speed decrease are checked.
If they exceed a certain value, the fuel supply is partly reactivated on the basis of a logic which makes provision for the 'gentle accompaniment' of the engine whilst idling.
Having reached the idle condition, the normal functions are restored.
The fuel cut off is only activated 20 seconds after the engine is started up.



Fuel vapour recovery

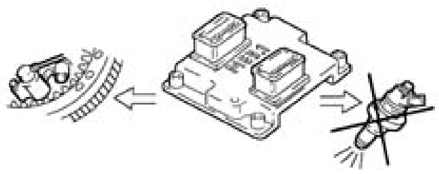
The (polluting) fuel vapours, collected in an activated-charcoal filter (canister), are sent to the inlet ducts to be burnt.
This takes place via a solenoid valve operated by the control unit which keeps it closed for 60 seconds after starting after which it keeps it open for 90 seconds.
During this period (90 seconds), the Lambda sensor measures the carburation which is compared by the control unit with the basic map.
If there are no variations, the control unit closes the solenoid valve, otherwise it keeps it open for a further 90 seconds allowing the washing of the canister.
The filter scavenging flow rate is restricted to a small percentage of the flow meter air flow rate reading so that the driveability and the adjustment of the engine in terms of emissions is disturbed as little as possible.



Control of the maximum rpm

Depending on the rpm reached by the engine, the control unit:

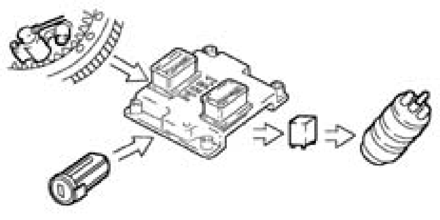
- over 6800 rpm cuts off the supply to the injectors (it is allowed to reach a maximum of 7000 rpm for a maximum of 5 s).
- below 6600 rpm it restores the operation of the injectors.



Control of fuel pump

The control unit:

- supplies the electric fuel pump
- ignition in ON position (for 5 s)
- ignition in START position and engine speed > 25 rpm
- cuts off the supply to the fuel pump:
- with ignition in OFF position
- with the engine rpm < 25 rpm.

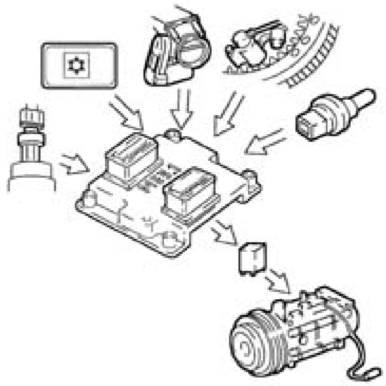


Connection to the climate control system

When the climate control is switched on, the compressor absorbs power from the engine.
In idle conditions, the control unit adapts the air flow rate to the new power requirements, with the advantage of maintaining optimum driveability.

The control unit excludes the compressor:

- beyond 6500 rpm;
- beyond a certain engine coolant temperature level (117° C);
- during starting.



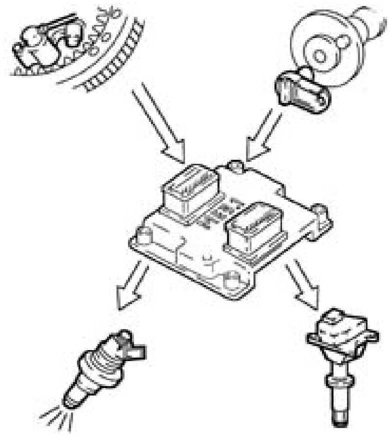
Recognition of cylinder position

During each engine revolution, the control unit recognizes which cylinder is at the power stroke:

- it operates the injection and ignition sequence at the appropriate cylinder.

If the timing sensor is faulty, the control unit does not recognize whether cylinder no. 1 or cylinder no. 5 is in the power stroke and implements the following strategies:

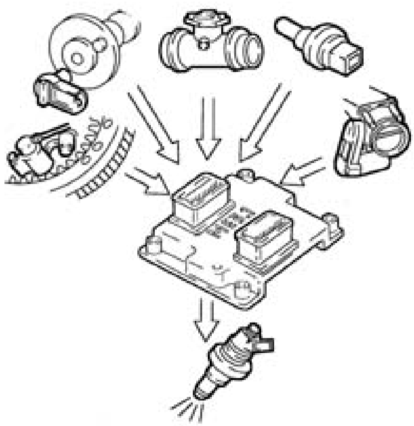
- with the engine started up, the engine runs smoothly thanks to the cylinder sequence memory
- if the engine cuts out and is started up again, the ignition in pairs of coils with the lost spark is activated, the control of the detonation is deactivated and a fixed delay is applied for all cylinders.



Control of the optimum injection time for each cylinder

According to special maps, the control unit calculates the optimum injection time for each cylinder:

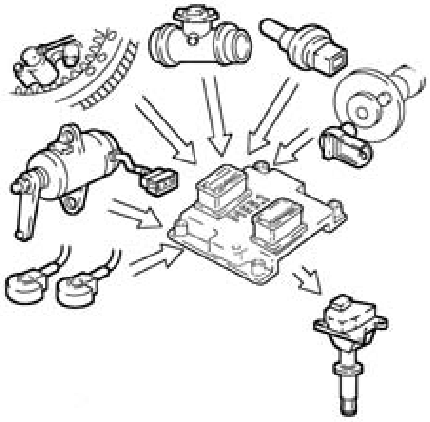
- it modifies the injector opening starting 'point'
- it keeps the closing 'point' in the map, selected on the basis of the engine speed, fixed
- the fuel injection is sequential and phased for each cylinder (S.E.F.I.).



Adjustment of ignition advance values

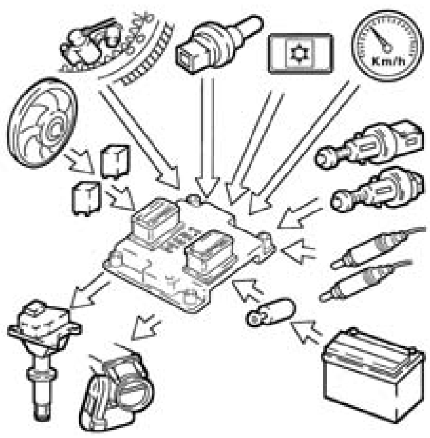
The control unit processes the signals coming from the sensors and determines:

- the ignition advance for each cylinder
- the ignition delay at the cylinder required (according to the detonation).



Control of the idle speed

The control unit recognizes the idle condition by the accelerator pedal being in the 'released' position.
To control the idle speed according to the consumers switched on and brake/clutch pedal signals, the control unit operates the position of the motorized butterfly.

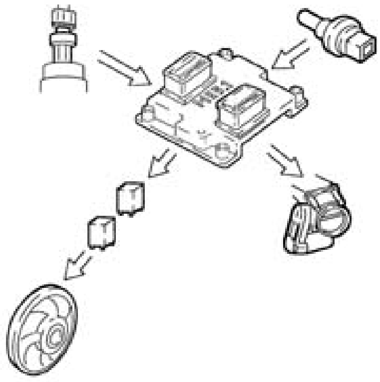


Control of the electric fans

The control unit controls the engagement of the fan according to the temperature of the coolant:

- temperature for switching on 1st speed 95° C
- temperature for switching on 2nd speed 102° C

If the air conditioning system is switched on, the control unit engages the 1st fan speed.
In the absence of the coolant temperature signal, the control unit activates the recovery function and switches on the fan 2nd speed until the error disappears.
When the fans are activated, the opening of the throttle is increased to prevent a fall in engine revs.



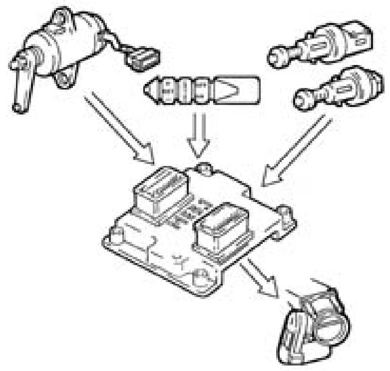
Control of the cruise control system (where fitted)

According to the position of the Cruise Control lever, the control unit directly operates the motorized butterfly to control and maintain the vehicle speed memorized.
A warning light in the dashboard, activated by the control unit, indicates whether the system is operating or not.

The cruise control is momentarily disabled:

- by operating the brake,
- by operating the clutch;

the 'recall' button is used to return to the speed memorized.
The cruise control is not disabled if there is an acceleration request (e.g. overtaking) and the vehicle automatically returns to the speed set as soon as the accelerator is released.
The ASR function (anti-spin) has priority over the cruise control for safety reasons.

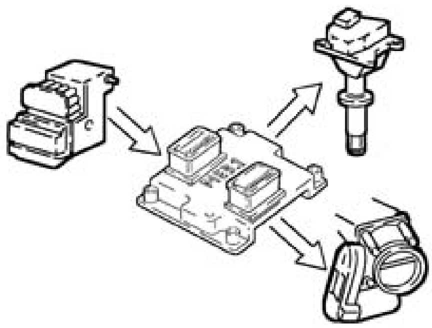


Connection with the abs/asr control unit (where fitted)

The dialogue between the engine control unit and the ABS/ASR control unit takes place via the CAN line available on both control units.

If the wheels are slipping (signalled by the ABS/ASR control unit), the control unit reduces the drive torque through:

- a reduction in the ignition advances.
- reducing the throttle opening angle.



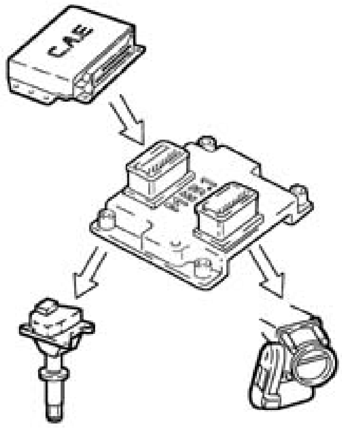
Connection with the automatic transmission control unit (where fitted)

The dialogue between the engine control unit and the CAE automatic transmission control unit takes place via the CAN line available on both control units.

If the wheels are slipping (signalled by the CAE control unit), the injection control unit reduces the drive torque through:

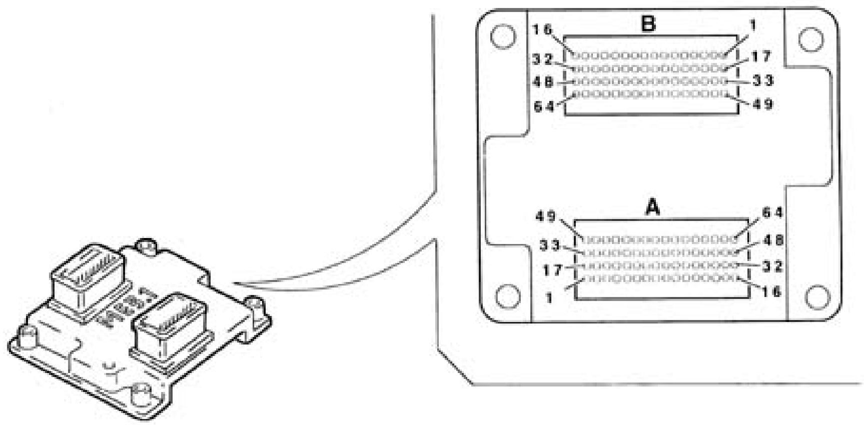
- a reduction in the ignition advances.
- reducing the throttle opening angle.

Recovery: if the CAN line is faulty, the injection control unit identifies the position (D - P - N) of the gear selector through the signal coming from a switch under the selector. If the lever is in position D, the control unit reduces the torque.
The CAE control unit implements a special recovery logic.



ME3.1 injection/ignition control unit

The control unit is fitted in the engine compartment, on the intake chamber.
The control unit memory is the 'flash EPROM' type, i.e. reprogrammable from the outside without intervening on the hardware.
The replacement of the injection control unit or the integrated throttle body means that the self-learning procedure has to be carried out.
PINS



A1, Cruise Control warning light
A2, Fuel vapour solenoid valve operation
A3, Alfa Romeo CODE connection
A4, Not connected
A5, Gear selector (auto. trans. only)
A6, Compressor engagement request
A7, Power supply for accelerator pedal potentiometer
A8, Signal for potentiometer - 1 accelerator pedal
A9, Quadrinary - Fan 1st speed request
A10, Cruise Control ON/OFF
A11, Automatic transmission version code
A12, CAN-L line
A13, Compressor relay control
A14, Not connected
A15, Direct supply
A16, Supply controlled by ignition, via main relay
A17, Not connected
A18, Cruise Control warning light
A19, Engine coolant overheating warning light
A20, Preparation for Flash Programming
A21, Not connected
A22, Fuel level sensor
A23, Not connected
A24, Earth for potentiometer - 1 accelerator pedal
A25, Earth for potentiometer - 2 accelerator pedal
A26, Brake lights switch
A27, Brake lights switch
A28, SPORT function switch
A29, CAN-H line
A31, Fuel pump relay feed
A31, Main relay activation

A32, Supply controlled by ignition, via main relay
A33, Not connected
A34, SPORT function warning light
A35, Rev counter signal
A36, Not connected
A37, Not connected
A38, Signal from air conditioner
A39, Not connected
A40, Signal for potentiometer - 2 accelerator pedal
A41, Quadrinary - fan 2nd speed request
A42, Cruise Control Resume
A43, Cruise Control SET +
A44, Speedometer sensor signal
A45, CAN-H line
A46, Injection warning light
A47, Supply controlled by ignition
A48, Supply controlled by ignition, via main relay
A49, Not connected
A50, Operation of fan 1st speed
A51, Not connected
A52, Fuel consumption signal
A53, Diagnostic connection (K line)
A54, Air temperature sensor signal
A55, Not connected
A56, Supply for accelerator pedal potentiometer
A57, Air flow meter signal
A58, Cruise Control SET -
A59, Clutch pedal switch
A60, Oil pressure switch
A61, CAN-L line
A62, Operation of fan 2nd speed
A63, Air flow meter supply
A64, Not connected
B1, Throttle body motor earth
B2, Lambda sensor heating (pre-cat. 2) (front bank)
B3, Operation of injector for cyl. 2
B4, Not connected
B5, Not connected
B6, Detonation sensor 2 reference earth
B7, Lambda sensor earth (pre-cat. 2)
B8, Not connected
B9, Not connected
B10, Engine rpm sensor
B11, Not connected
B12, Lambda sensor earth (post-cat. 2)
B13, Not connected
B14, Cylinder 3 coil operation
B15, Cylinder 2 coil operation
B16, Cylinder 1 coil operation
B17, Throttle body motor supply
B18, Lambda sensor heater (post-cat. 2)
B19, Operation of injector for cyl. 1
B20, Operation of injector for cyl. 3
B21, Not connected
B22, Detonation sensor 1
B23, Lambda sensor signal (pre-cat. 1) (rear bank)
B24, Potentiometer - 1 throttle body
B25, Engine coolant temperature
B26, Sensors reference earth
B27, Not connected
B28, Lambda sensor signal (post-cat. 1)
B29, Not connected
B30, Cylinder 6 coil operation
B31, Cylinder 5 coil operation
B32, Cylinder 4 coil operation
B33, Throttle body motor earth
B34, Lambda sensor heater (pre-cat. 1)
B35, Operation of injector for cyl. 4
B36, Operation of injector for cyl. 6
B37, Operation of EGR solenoid valve (preparation)
B38, Detonation sensor 2
B39, Lambda sensor signal (pre-cat. 2) (front bank)
B40, Potentiometer 2 throttle body
B41, Not connected
B42, Timing sensor signal
B43, Not connected
B44, Lambda sensor signal (post-cat. 2)

B45, Not connected
B46, Not connected
B47, Not connected
B48, Not connected
B49, Throttle body motor supply
B50, Lambda sensor heater (post-cat. 1)
B51, Not connected
B52, Operation of injector for cyl. 5
B53, Not connected
B54, Detonation sensor 1 reference earth
B55, Lambda sensor earth (pre-cat. 1)
B56, Not connected
B57, Not connected
B58, Throttle body potentiometers supply
B59, Engine rpm sensor
B60, Lambda sensor earth (post-cat. 1)
B62, Not connected
B63, Not connected
B64, Not connected

For the remaining components, refer to the ME2.1 injection/ignition system.